UNIVERSIDADE DE LISBOA

INSTITUTO DE EDUCAÇÃO

INTEGRAÇÃO DA FILOSOFIA DA QUÍMICA NO CURRÍCULO DE FORMAÇÃO INICIAL DE PROFESSORES. CONTRIBUTOS PARA UMA FILOSOFIA DO ENSINO

ANEXOS

MARCOS ANTONIO PINTO RIBEIRO

Doutoramento em Educação

Desenvolvimento Curricular

2014

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MARCOS ANTONIO PINTO RIBEIRO

Tese orientada pelo Prof. Dr. Ricardo Lopes Coelho e pela profª. Dra. Maria Helena Mendes Carneiro Peralta especialmente elaborada para a obtenção do grau de Doutor em Educação na Especialidade em Desenvolvimento Curricular

2014

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1. Análise das Edições da revista Hyle

1.1 Edições da revista Hyle

EDIÇÃO	TEMÁTICA	EDIÇÃO	TEMÁTICA
Hyle 1 (1995)	Geral	Hyle 9.2 (2003)	Estética e visualização 2
Hyle 2 (1996)	Geral	Hyle 10.1 (2004)	Geral
Hyle 3 (1997)	Geral	Hyle 10.2 (2004)	Nanotecnologia 1
Hyle 4.1 (1998)	Geral	Hyle 11.1 (2005)	Nanotechnologia 2
Hyle 4.2 (1998)	Geral	Hyle 11.2 (2005)	geral
Hyle 5.1 (1999)	Geral	Hyle 12.1 (2006)	A imagem plublica da química 1
Hyle 5.2 (1999)	Modelos em química1	Hyle 12.2 (2006)	A imagem plublica da química 2
Hyle 6.1 (2000)	Modelos em química 2	Hyle 13.1 (2007)	A imagem plublica da química 3
Hyle 6.2 (2000)	Modelos em química 3	Hyle 13.2 (2007)	Geral
Hyle 7.1 (2001)	Geral	Hyle 14.1 (2008)	Geral
Hyle 7.2 (2001)	Etica em química 1	Hyle 15.1 (2009)	Bionanotechnologia 1
Hyle 8.1 (2002)	Etica em química 2	Hyle 16.1 (2010)	Bionanotechnologia 2
Hyle 8.2 (2002)	geral	Hyle 16.2 (2010)	geral
Hyle 9.1 (2003)	Estética e visualização 1	Hyle 17.1 (2011)	Geral
Hyle 18.1 (2012)	Matemática e química		

1.2 Corpo editorial da revista Hyle

1.3 Conselho editorial da ISPC

Presidente	Rom Harré	Georgetown University, Oxford University
Comite executivo	Brigitte van Tiggelen	Catholic University of Louvain, Belgium
	Michael Akeroyd,	Bradford College, UK
	Robin Hendry,	University of Durham, UK
	Paul Needham,	University of Stockholm, Sweden
	Klaus Ruthenberg	Fachhochschule Coburg Germany
	Eric Scerri	University of California, Los Angeles, USA

1.4 Congressos de filosofia da química realizados pela ISPC

Tabela 1: Trabahos apresentados no primeiro congresso da ISPC

Autor	Tema
Michael F. Akeroyd (Bradford, UK)	*Aspects of Theory Appraisal: Some Biochemical Examples* and *Fuzzy Logic and Physical Organic Chemistry*
Davis Baird (Columbia/SC, USA)	*Encapsulating Knowledge: the Direct Reading Spectrometer*
John Christie (Bundoora, Australia)	*Philosophical Questions from a Durable Model Theory of Chemical Reactions*
Maureen Christie (Melbourne, Australia)	*Prediction in Science: The Case of the Ozone Investigation*
Martin Eisvogel (Konstanz, Germany)	*Radicals, Types and Structures*
Paul Needham (Stockholm, Sweden)	*Chemical Considerations and Duhems General Philosophy of Science*
Daniel Rothbart (Washington D.C., USA)	*Hackings Turn to Anti-Realism*
Klaus Ruthenberg (Coburg, Germany)	*On Ostwalds Philosophy of Chemistry*
Eric Scerri (Pasadena/CA, USA)	*In Praise of the Periodic System*
Rein Vihalemm (Tartu, Estonia)	*Classification and Construction: On the Nature of Chemistry as a Science*
Eva Zielonacka-Lis (Poznan, Poland)	*BioOrganic Chemistry as a Boundary Science*

Tabela 2: trabalhos apresentados no segundo congresso da ISPC

Participante	Tema
Klaus Ruthenberg (Coburg university of aplied sciences, Alemanha)	Philosophy and Alchemy
Heinrich Zollinger (Federal Institute of Technology, Zürich, Switzerland)	"Logic, Psychology and Serendipity of Scientific Discoveries: a Case Study in Contemporary Chemistry"
Tony Edmonds (University of Loughborough, UK)	"Meaning and Misunderstanding: Translation and Interpretation of Pliny's Iron/Galnut reaction",
Michael Akeroyd (Bradford & Ilkley College, UK)	"Fuzzy Reasoning in Physical Organic Chemistry"
Eric Scerri (Purdue University, USA)	"The Metaphysics of Chemistry" into "Naive Realism, Reduction, and the Intermediate Position of Chemistry"
John Green(University College, London, UK)	"Ingold's 'Mesomerism', Pauling's 'Resonance' and the Soviet Chemical Controversy"
Davis Baird (University of South Carolina, USA)	"Chemistry and Reduction in the Light of Instruments"
Daniel Rothbart (George Mason University, USA)	"Are Chemical Instruments driven by Nature or Nurture?
Joseph Earley (Georgetown University, USA)	"How constrained is the emergence of Novel Dynamic Coherence in far-from-equilibrium systems?
Arie Leegwater (Calvin College, USA)	Linus Pauling's Methodology and the Development of the

	Chemical Bond
Eva Zielonacka-Lis (University of Poznan, Poland)	"Some Remarks on the Specificity of Scientific Explanation in Chemistry"
Rein Vihalemm (University of Tartu, Estonia)	"An Aspect of the Relationship between Physics and Chemistry: When did Chemistry become a quantitative science?

Tabela 3: Trabalhos apresentados no sexto congresso da ISPC

Autor	Temática
Joachim Schummer	The origin and prospects of Philosophy of Chemistry
Rom Harré	The origin and nature of structural explanation
Jap Van Brakel	Review of the debate on 'reduction'
Darden	Mechanism' in biochemistry,
Scerri	Chemical education suffers from philosophical misunderstanding on the part of the researchers
Ellis and Seely	How NSF supports philosophy of chemistry
Berrie	Chemistry and Art are two 'ways of seeing'

1.5 Principais assuntos discutidos nas revistas Hyle e foundations of chemistry

Tema	Hyle	Found. Chem.	Ano
Autonomia da química	0	2	2006, 20052011
Ciencia patológica	1	0	2002
Classicos da filosofia	1	3	2009, 2006, 2001 (2)
Classificação	0	2	2005
Computação quimica	0	2	2006
Conceito químicos	1	19	2007 (3), 2008, 2009 (7), 2011, 2010, 2001, 2002(3), 2005 (2), 2004, 1999 (2)1997
Descoberta em química			2009
Discurso da química	3	1	2007, 1998,1999 2010
Distinção entre Química e técnica	1	0	1997
Educação química	1	10	20022006 (5) 2008 (1)1999, 2003, 2007, 2004
Emergencia	2	0	2002
Estética da química	4	0	2003 (5)
Etica e química	11	0	2001 (5), 2005 (3) 2002 (2)
Evolução do conhecimento químico	1	1	2003,1999
Explicação	2	6	2005, 2008 (3), 200920041997, 2005
História da quimica verde	O	1	2010
Imagem da filosofia da química	0	1	2000
Imagem publica da química	10	0	2007 (2), 1998, 2006 (7)
Instrumentação química	2	2	2000, 1999 1997 (2)
Investigação e risco	1	0	2002
Leis em Química	0	3	2003 (2), 2005
Linguagem	3	1	1997,2001, 20042009
Matemática química	0	1	2005
Mereologia	0	1	2011
Método Abinitio	0	1	2000
Método computacional	0	1	2004
Modelagem computacional	1	0	2000
Modelos químicos	12	0	2000 (7), 1998, 2004 2002,2003, 2001 (2),1999
Nanotecnologia	5	0	2004 (3), 2005 (2)
Negligenciamento da filosofia da química	0	2	1999
Ontologia	6	13	1998 (2), 2001 (2), 2004, 20042000, 2002, 2005, 2005 (2), 2006, 2008 (2), 2010, 2005, 2009 (2)2003
Politica e ciencia	0	1	2004
Química computacional	1	0	2000
Química e tecnologia	1	0	2010, 2009, 1997
Razão história	1	1	20072010
Razão prática	0	1	2002
Realism	0	3	2010, 2006, 2007
Redução	1	5	2007 2006,2002, 2001, 2006, 2010 (2)
Relações com filosfia da mente	1	0	2008
Revolução química	1	2	20102008, 2010
Sistema periódico	0	27	2010, (7), 2000, 2001 (3), 2002, 2003 (2), 2005 (3), 2006, 2007 (5), 2008 (3), 2009,
Sistemas complexos	1	0	2001
Status epistemológico das relações	1	0	2010
Superveniencia	0	1	2008
Tecnologia	0	1	2005

Teoria	3	3	2008 (3)1999, 2007, 2008
Visões da química	1	0	1998, 2004
Visualização	4	0	2003, 2006, 2003, 2001

1.6 Planilhas

1.6.1 categorias analisadas nas revistas

Tabela 4: relação de categorias analisadas na produção de filosofia da química

Categorias	Subcategorias	Descritores
Institucionalização	Revistas próprias	
	Associações	
	Congressos	
	Números especiais de outras revistas	
	Principais eventos	
	Livro	
Autores	País	
	Formação	
	Instituição	
	Temática	
Temáticas	Principais temáticas	
	Transversais	
	Debates controversos	
Relações	Com física	
	Com biologia	
	Com clássicos da filosofia	
	Com filósofos da ciência	
	Com outros saberes	
	Químicos filósofos	

Fonte: Tabela criada pelo autor

1.6.2 planilha da revista foundations of chemistry

ano	autor	título	palavras chaves	Resumo
	conal boyce	on the boundary between laboratory 'givens' and laboratory 'tangibles	keywords ontology · laboratory procedure · white box · imagination ·basic chemistry · atomo centric	abstract from the 4-part procedure/observations/data/analysis structure of a laboratory report (generalized from italian, chinese and us sources), we distill a fifth flavor, the givens, whose flip side is the freedoms or tangibles of an experiment. (stated in terms of computer science, we are trying to find inputs and outputs, but these turn out to be surprisingly vague in chemistry.) then, in the service of a white-boxing ethos (which sounds less severe than 'anti black-boxing'), we establish a movable boundary between givens and tangibles, with implications for 'ontological attitudes' and for the future of chemistry. next, in revisiting a 2002 exchange between schummer and laszlo, which might be paraphrased as the chemist-as-philosopher versus chemist-as-artisan, we apply a second kind of sliding scale which seems to harmonize the discussion. finally, on a possibly quixotic note, we look briefly at a third kind of sliding scale, now aimed squarely at ontology itself. for illustrative purposes, we adopt an atomocentric viewpoint (as distinct from atomistic), and assign it the provisional name 'fuzzy ch4 ontology'.
	alan f. chalmers	atom and aether in nineteenth-century physical science	keywords atoms _ aether _ chemical formulae _ scientific realism	abstract this paper suggests that the cases made for atoms and the aether in nineteenthcentury physical science were analogous, with the implication that the case for the atom was less than compelling, since there is no aether. it is argued that atoms did not play a productive role in nineteenth-century chemistry any more than the aether did in physics. atoms and molecules did eventually find an indispensable home in chemistry but by the time that they did so they were different kinds of entities to those figuring in the speculations of those natural philosophers who were atomists. advances in nineteenth-century chemistry were a precondition for rather than the result of the productive introduction of atoms into chemistry.
1999	richard d. Harcourt	the atomic shell-structure formula 2*n*2		
1999	eric r. scerri	a critique of atkins' periodic kingdom and some writings on electronic structure		abstract. this article consists of a critique of the writings of peter atkins. the topics discussed include the quantum mechanical explanation of the periodic system, the aufbau principle and the order of occupation of orbitals by electrons. it is also argued that atkins fails to appreciate the philosophical significance of the more general version of the pauli exclusion principle and that this omission has ramifications in the popular presentation of chemistry as well as chemical education and philosophy of chemistry in general

1999	j. van brakel	on the neglect of the philosophy of chemistry		abstract. in this paper i present a historiography of the recent emergence of philosophy of chemistry. special attention is given to the interest in this domain in eastern europe before the collapse of the ussr. it is shown that the initial neglect of the philosophy of chemistry is due to the unanimous view in philosophy and philosophy of science that only physics is a *proper* science (to put in kant's words). more recently, due to the common though incorrect assumption that chemistry can in principle be reduced to physics, the neglect continued, even when interest in sciences such as biology and psychology entered more strongly in philosophy of science. it is concluded that chemistry is an autonomous science and is perhaps a more 'typical' science than physics. kant
1999	robert m. richman	the use of one-electron quantum numbers to describe polyelectronic systems		abstract. atomic states are rigorously characterized by the total orbital angular momentum and the total spin angular momentum, but chemists persist in the use of electron configurations based on one-electron quantum numbers and simplified rules for predicting ground state configurations. this practice is defended against two lines of criticism, and its use in teaching chemistry isencouraged with the claim that the inductive approch of mendeleev and the deductive approach initiated by schrödinger compose the consummate example of that interaction of empirical and rational epistemologies that defines how chemists think.
1999	robert j. good	why are chemists 'turned off' by philosophy of science?		abstract. the most immediate reason why chemists are unenthusiastic about the philosophy of science is the historic hostility of important philosophers, to the concept of atoms. (without atoms, discovery in chemistry would have proceeded with glacial slowness, if at all, in the last 200 years.) other important reasons include the anti-realist influence of the philosophical dogmas of logical positivism, instrumentalism, of strict empiricism. though (as has been said) these doctrines have recently gone out of fashion, they are still very influential. a diagram of the methodology of experimental research is proposed, in the form of a flow sheet, with feedback. the model is developed as a multi-level expansion of a diagram of the hypothetico-deductive model. it recognizes that strong mutual support, or interlocking, of research endeavors is important, at the underlying level or levels where explanatory causation contributes to scientific understanding. (mutual support at the *laboratory* level is generally weak or trivial.) the multiplicity of explanatory levels, and the interlocking, point to solutions to some well-known problems, such as the origin of the hypotheses, and even a resolution to the underdetermination problem.

2000	theodor benfey	reflections on the philosophy of chemistry and a rallying call for our discipline		abstract. biology in the popular mind remains tied to the doctrines of the struggle for survival and the survival of the fittest. physics is linked to the heat death of the universe – the inexorable march towards greater disorder, increasing entropy. our field, on the other hand, focuses on ordered structures, molecules and crystals, and their aggregates, and what holds them together. the philosophy of chemistry is centered on affinity, cohesion, the architecture of the very small, attraction, harmony, and, if you permit, beauty. our discipline is the voice of the twenty-first century, a message, a clarion call of life, of hope. this paper addresses failures of reductionist and deterministic claims in the face of the cussedness of chemical facts. it will examine uncertainty principles, edmundwhitaker's postulates of impotence, gerald holton's themata, isaiah berlin's warning – and the wisdom of the chinese. we can teach the world the need for humility in the face of the wonder and mystery of our world.
2000	f. michael akeroyd	the foundations of modern organic chemistry: the rise of the hughes and ingold theory from 1930–1942		abstract. the foundations of modern organic chemistry were laid by the seminal work of hughes and ingold. the rise from being an interesting alternative hypothesis in 1933 to being the leading theory (outside the usa) in 1942 was achieved by a multiplicity of methods. these included: the construction of a new scientific notation, the rationalisation of some seemingly contradictory reported data, the refutation of the experimental work of one of their persistent critics, the use of conceptual arguments and also the achievement of a score of successful predictions which exceeded the score of unsuccessful predictions. within the usa it was felt that the hughes/ingold system, whilst representing a considerable advance, had achieved spectacular success *in spite of* its attractively simple basic assumptions, and represented merely an interim stage on the way towards a more comprehensive theory. however, the flexible, simple notation was adopted without modification, leading to a change in the way practitioners of synthetic organic chemistry were, and still are, trained to think. in a conclusion the author claims that this historical episode does not lend any support to the philosophical position of thomas kuhn.
2000	john g. Mcevoy	in search of the chemical revolution: interpretive strategies in the history of chemistry		abstract. in recent years the chemical revolution has become a renewed focus of interest among historians of science. this interest is shaped by interpretive strategies associated with the emergence and development of the discipline of the history of science. the discipline occupies a contested intellectual terrain formed in part by the development and cultural entanglements of science itself. three stages in this development are analyzed in this paper. the interpretive strategies that characterized each stage are elucidated and traced to the disciplinary interests that gave rise to them. while positivists and whigs appropriated the history of science to the justificatory and celebratory needs of science itself, postpositivists linked it to philosophical models of rationality, and sociologists of knowledge sought its sociological reconstruction. since none of these strategies do justice to the complexity of historical events, a model of the chemical revolution is outlined which upholds the autonomy and specificity of history and the methods used to study it.

2001	nikos psarros	the lame and the blind, or how much physics does chemistry need?		bomber and paganini, two small-time gangsters, are struck with bad luck while trying to crack a bank safe. as a result, bomber loses his sight and paganini is chained to a wheel chair. stuck together by fate, paganini navigates and bomber pulls the chair. they hate but also depend on each other as they face a common future
2001	helge kragh	the first subatomic explanations of the periodic system		abstract. attempts to explain the periodic system as a manifestation of regularities in the structure of the atoms of the elements are as old as the system itself. the paper analyses some of the most important of these attempts, in particular such works that are historically connected with the recognition of the electron as a fundamental building block of all matter. the history of the periodic system, the discovery of the electron, and ideas of early atomic structure are closely interwoven and transcend the physics–chemistry boundary. it is pointed out that j. j. thomson's discovery of the electron in 1897 included a first version of his electron atomic model and that it was used to suggest how the periodic system could be understood microphysically. thomson's theory did not hold what it promised, but elements of it were included in niels bohr's first atomic model. in both cases, thomson's and bohr's, the periodic system played an important role, heuristically as well as justificatory. 1.
2001	michael chayut	from the periphery: the genesis of eugene p. wigner's application of group theory to quantum mechanics		abstract. this paper traces the origins of eugene wigner's pioneering application of group theory to quantum physics to his early work in chemistry and crystallography. in the early 1920s, crystallographywas the only discipline in which symmetry groups were routinely used.wigner's early training in chemistry, and his work in crystallography with herman mark and karl weissenberg at the kaiser wilhelm institute for fiber research in berlin exposed him to conceptual tools which were absent from the pedagogy available to physicists for many years to come. this both enabled and pushed him to apply the group theoretic approach to quantum physics. it took many years for the approach first introduced by wigner in the 1920s – and whose reception by the physicists was initially problematical – to assume the pivotal place it now holds in physical theory and education. this is but one example that attests to the historic contribution made by the periphery in initiating new types of thought-perspectives and scientific careers.1
2001				

2002	claus jacob	philosophy and biochemistry: research at the interface between chemistry and biology		abstract. this paper investigates the interface between philosophy and biochemistry. while it is problematic to justify the application of a particular philosophical model to biochemistry, it seems to be even more difficult to develop a special "philosophy for biochemistry". alternatively, philosophy can be used in biochemistry based on an alternative approach that involves an interdependent iteration process at a philosophical and (bio)chemical level ("exeter method"). this useful iteration method supplements more abstract approaches at the interface between philosophy and natural sciences, and serves the biochemical community to systematically locate logical inconsistencies that arise from more theoretical aspects of the scientific process. initial cycles of this iteration process identify the *in vitro–in vivo* problem as a central epistemological difficulty in biochemical research. while previous attempts have generated *ad hoc* rules to mend the gap between chemistry, biochemistry and biology in order to justify *in vitro* experimentation, this paper concludes that *in vitro* experimentation is heavily based on chemistry and cannot derive *definite* statements about biological processes. it can, however, generate results that will influence the direction of future biological research. the consequence is that the relationship between *in vitro* and *in vivo* experimentation is more of a psychological or social one than of a logical nature. apart from highlighting these inconsistencies in biochemical thinking ("problem awareness"), the exeter method demands an improvement of biochemical terminology that contains separate and unequivocally defined terms for *in vitro* and *in vivo* systems.
2002	nathan m. brooks	developing the periodic law: mendeleev's work during 1869–1871		introduction in october 1867, dmitrii ivanovichmendeleev (1834–1907) moved from the chair [*kafedra*] of technical chemistry to the chair of general chemistry at st. petersburg university, upon the retirement of his former chemistry teacher, a. a. voskresenskii. one of the main duties associated with this new position was teaching the introductory chemistry course for students in the physics-mathematics section [*fakul'tet*] at the university. mendeleev quickly reviewed numerous textbooks of chemistry for possible use in his course, but not finding one that satisfied him, he decided to write his own
2003	hrvoj vanˇ cik	philosophy of chemistry and limits of complexity		abstract. the problem of complexity is considered within the framework of concepts developed in recent studies in the philosophy of chemistry. according to previously expressed ideas about *diminishing interactions* (vanˇcik, 1999), as well as on the basis of the concept of levels of complexity, we speculate here that the complexity should approach its final limit. on the other hand, dynamical complexity may grow *ad infinitum*, and relativistic effects can only limit it. impacts of these considerations on a possible change of actual paradigm of cosmology, especially on the *anthropic principle*, are also discussed
2003	john r. christie and maureen christie	chemical laws and theories: a response to vihalemm		abstract. a recent article by vihalemm (foundations of chemistry, 2003) is critical of an earlier essay.we find that there is some justification for his criticism of vagueness in defining terms. nevertheless the main conclusions of the earlier work, when carefully restated to deflect vihalemm's criticisms, are unaffected by his arguments. the various dicta that are used as the bases of chemical explanations are different in character, and are used in a different way from the laws and theories in classical physics.

2004	andrea i.	woody telltale signs: what common explanatory strategies in chemistry reveal about explanation itself		
2004	heather douglas	prediction, explanation, and dioxin biochemistry: science in public policy		
2004	eric r. scerri	just how ab initio is ab initio quantum chemistry?		quantum mechanics has been the most spectacularly successful theory in the history of science. as is often mentioned the accuracy to which the gyromagnetic ratio of the electron can be calculated is a staggering nine decimal places. quantum mechanics has revolutionized the study of radiation and matter since its inception just over one hundred years ago. the impact of the theory has been felt in such fields as solid state physics, biochemistry, astrophysics, materials science and electronic engineering, not to mention chemistry, the subject of this conference
2004	bretislav friedrich	hasn't it? *a commentary on eric scerri's paper "has quantum mechanics explained the periodic table?", now published under the title "just how ab initio is ab initio quantum chemistry*		exact sciences cherish approximations. more often than not, resorting to approximations is a matter of *necessity*: that is the case when a problem cannot in principle be solved exactly. for instance, many-body problems fall all in this category, whether they are classical or quantum (see, e.g., meyer, 1999). we note that here *many* means more than two; hence there are very many *many*body problems. approximations are also introduced when seeking a *qualitative understanding* of a problem: approximations (called in this context *models* or *treatments*) reveal the structure of problems and aid in identifying analogies with other problems, thus adding to the sense that we can make of them. an excellent example of both of the
2005	michael laing	a revised periodic table: with the lanthanides repositioned		abstract. the lanthanide elements from lanthanum to lutetium inclusive are incorporated into the body of the periodic table. they are subdividedinto three sub-groups according to their important oxidation states:la to sm, eu to tm, yb and lu, so that eu and yb fall directly below ba;la, gd, lu form a column directly below y; ce and tb fall in a vertical line between zr and hf. pm falls below tc; both are radioactive, and not naturally occurring. the elements with easily attained 2þ and 4þ oxidation states are grouped and clearly differentiated. gadolinium has an important position as the centre of four triads in the block of elements that surround it – la, gd, lu; ba, gd, hf; eu, gd, tb; yb, gd, ce. this new arrangement has the advantages of compactness, simplicity and clarity – there are no tie lines; and important oxidation states of these metals are emphasized. the actinides are also accommodated within this system, and element 114 falls naturally below lead in group 14.

2005	a. korobov	simple chemical reactions in the solid state: towards elaborating a conception		abstract. in contrast to the conventional homogeneous kinetics, there is no conception of a simple reaction in the solid-state reaction kinetics. the geometric-probabilistic phenomenology currently in use is not adequate for describing the interplay between the chemical mechanism and the observed kinetic behaviour. an attempt is made to formulate a conception of simple reaction in the solid state as a basis for constructing kinetic models of involved reactions.
2005	olimpia lombardi and martín labarca	the ontological autonomy of the chemical world		abstract. in the problem of the relationship between chemistry and physics, many authors take for granted the ontological reduction of the chemical world to the world of physics. the autonomy of chemistry is usually defended on the basis of the failure of epistemological reduction: not all chemical concepts and laws can be derived from the theoretical framework of physics. the main aim of this paper is to argue that this line of argumentation is not strong enough for eliminate the idea of a hierarchical dependence of chemistry with respect to physics. the rejection of the secondary position of chemistry and the defense of the legitimacy of the philosophy of chemistry require a radically different philosophical perspective that denies not only epistemological reduction but also ontological reduction. only on the basis of a philosophically grounded ontological pluralism it is possible to accept the ontological autonomy of the chemical world and, with this, to reverse the traditional idea of the 'superiority' of physics in the context of natural sciences.
2005				
2005	torsten wilholt	explaining models: theoretical and phenomenological models and their role for the first explanation of the hydrogen spectrum		abstract. traditional nomological accounts of scientific explanation have assumed that a good scientific explanation consists in the derivation of the explanandum's description from theory (plus antecedent conditions). but in more recent philosophy of science the adequacy of this approach has been challenged, because the relation between theory and phenomena in actual scientific practice turns out to be more intricate. this critique is here examined for an explanatory paradigm that was groundbreaking for 20th century physics and chemistry (and their interrelation): bohr's first model of the atom and its explanatory relevance for the spectrum of hydrogen. first, the model itself is analysed with respect to the principles and assumptions that enter into its premises. thereafter, the origin of the model's explanandum is investigated. it can be shown that the explained ''phenomenon'' is itself the product of a host of modelling accomplishments that stem from an experimental tradition related to 19th century chemistry, viz. spectroscopy. the relation between theory and phenomenon is thus mediated in a twofold way: by (bohr's) theoretical model and a phenomenological model from spectroscopy. in the final section of the paper an account is outlined that nevertheless permits us to acknowledgee this important physico-chemical achievement as a case of (nomological) explanation.

2005	rein vihalemm	chemistry and a theoretical model of science: on the occasion of a recent debate with the christies		abstract. in the philosophy of chemistry a view is developed according to which laws of nature and scientific theories are peculiar in chemistry. this view was criticized in an earlier issue of the foundations of chemistry (vihalemm, foundation of chemistry 5(1): 7–22, 2003) referring to an essay by maureen and john christie (christie and christie, in n. bushan and s. rosenfeld (eds.), ofminds and molecules: new philosophical perspectives on chemistry. oxford university press, new york, 2000, pp. 34–50). this criticism was responded by the christies (christie and christie, foundations of chemistry 5(2): 165–177, 2003). in the present article the debate is continued. the main issues which need to be elucidated in order to carry the analysis forward are pointed out and discussed. the relevance of a theoretical model of science for the philosophy of chemistry is stressed.
2006	leslie s. forster	chromium photophysics – a prototypical case history	key words: phosphorscence, intermolecular rates, emission lifetimes, models in physical chemistry	abstract. science, in general, and chemistry in particular advances by methods that are difficult to codify. the availability of theories (models) and instrumentation play an important role but indefinable motivations to study individual phenomena are also involved. the area of chromium photophysics has a rich history that spans 150 years. a case history of the progression from the natural history stage to its present state reveals the way in which several factors that are common to much physical science research interact.
2006	eric r. scerri	commentary on allen & kinght's response to the lo¨ wdin challenge		abstract. this commentary provides a critical examination of a recent article by allen and knight in which the authors claim to provide the longsought explanation for the madelung, or n + ', n rule for the order of orbital filling in many-electron atoms. it is concluded that the explanation is inadequate for several reasons.
2006	jay a. labinger	organized skepticism, naiı¨ve methodism, and other –isms		abstract. the science wars have pitted defenders of science against those accused of attacking it with the weapons of constructivism and relativism. i argue that this defensive stance is in large part a consequence of two other -isms, organized skepticism and naı¨ve methodism, that play a significant, if mostly unconscious, role in how scientists tend to think about science, and suggest that increased awareness of these -isms may help dissipate the perceptions of hostility.
2006	donald j. wink	connections between pedagogical and epistemological constructivism: questions for teaching and research in chemistry		abstract. the rich and ongoing debate about constructivism in chemistry education includes questions about the relationship, for better or worse, between applications of the theory in pedagogy and in epistemology. this paper presents an examination of the potential to use connections of epistemological and pedagogical constructivism to one another. it examines connections linked to the content, processes, and premises of science with a goal of prompting further research in these areas.

2006	kevin c. de berg	the status of constructivism in chemical education research and its relationship to the teaching and learning of the concept of idealization in chemistry	key words: experience-based constructivism, discipline-based constructivism, idealization	abstract. a review of the chemical education research literature suggests that the term constructivism is used in two ways: experience-based constructivism and discipline-based constructivism. these two perspectives are examined as an epistemology in relation to the teaching and learning of the concept of idealization in chemistry. it is claimed that experience-basedconstructivism is powerless to inform the origin of such concepts in chemistry and while discipline-based constructivism can admit such theoretical concepts as idealization it does not offer any unique perspectives that cannot be obtained from other models. chemical education researchers do not consistently appeal to constructivism as an epistemology or as a teaching/ learning perspective and it is shown that, while it draws attention to worthwhile teaching/learning strategies, it cannot be considered as foundational to chemical education research and tends to be used more as an educational label than as an undergirding theory.
2006	liberato cardellini	the foundations of radical constructivism : an interview with ernst von glasersfeld		abstract. constructivism rejects the metaphysical position that ‘‘truth’’, and thus knowledge in science, can represent an ‘‘objective’’ reality, independent of the knower. it modifies the role of knowledge from ‘‘true’’ representation to functional viability. in this interview, ernst von glasersfeld, the leading proponent of radical constructivism underlines the inaccessibility of reality, and proposes his view that the function of cognition is adaptive, in the biological sense: the adaptation is the result of the elimination of all that is not adapted. there is no rational way of knowing anything outside the domain of our experience and we construct our world of experiences. in addition to these philosophical claims, the interviewee provides some personal insights; he also gives some suggestions about better teaching and problem solving. these are the aspects of constructivism that have had a major impact on instruction and have modified the manner many of us teach. the process of teaching as linguistic communication, he says, needs to change in a way to involve actively the students in the construction of their knowledge. because knowledge is not a transferable commodity, learning is mainly identified with the activity of the construction of personal meaning. this interview also provides glimpses on von glasersfeld’s life.

2006	keith s. taber	constructivism ’s new clothes: the trivial, the contingent, and a progressive research programme into the learning of science		abstract. constructivism has been a key referent for research into the learning of science for several decades. there is little doubt that the research into learners’ ideas in science stimulated by the constructivist movement has been voluminous, and a great deal is now known about the way various science topics may commonly be understood by learners of various ages. despite this significant research effort, there have been serious criticisms of this area of work: in terms of its philosophical underpinning, the validity of its most popular constructs, the limited scope of its focus, and its practical value to science teaching. this paper frames this area of work as a lakatosian research programme (rp), and explores the major criticisms of constructivism from that perspective. it is argued that much of the criticism may be considered as part of the legitimate academic debate expected within any active rp, i.e. arguments about the auxiliary theory making up the ‘protective belt’ of the programme. it is suggested that a shifting focus from constructivism to ‘contingency in learning’ will allow the rp to draw upon a more diverse range of perspectives, each consistent with the existing hard core of the programme, which will provide potentially fruitful directions for future work and ensure the continuity of a progressive rp into learning science.
2006	olimpi a lomba rdi labarc a	the ontological autonomy of the chemical world: a response to needham		in his comment to our article (foundations of chemistry, 7(2005), 125–48), paul needham considers our proposal of anontological pluralism as a radical alternative, not needed todeal with the problem of the relationship between chemistryand physics. needham agrees with us that ontological reduction cannot be simply assumed
2006	and marti´ n m. labarc a			
2007	r.j. deltete	wilhelm ostwald’s energetics 2: energetic theory and applications, part i		abstract. this is the second of a series of essays on the development and reception of wilhelm ostwald’s energetics. the first essay described the chemical origins of ostwald’s interest in the energy concept and his motivations for seeking a comprehensive science of energy. the present essay and the next discuss his various attempts, beginning in 1891 and extending over almost 3 years, to develop a consistent and coherent energetic theory. a final essay will consider reactions to this work and ostwald’s replies, and will also seek to evaluate his program of research. ostwald’s project – to reconstruct physics and chemistry ‘‘as a pure energetics’’ – is worth attending to for several reasons: first, because ostwald did ground-breaking work in chemistry (he was awarded a nobel prize in 1909 for his studies in catalysis and rates of reaction); second, because an important school of physical chemistry formed around him at leipzig, a school that promoted his ideas; and, finally, because he was a prominent and vigorous participant in debates at the end of the nineteenth century concerning the proper course of physical theory.

2007	geoff rayner - canha m æ megan oldfor d	the chemical ‘knight’s move’ relationship: what is its significance?	keywords periodic table _ periodic patterns _ knight’s move _ copper _ indium _ bismuth _ zinc _ tin _ polonium _ chemical formulas _ melting points	abstract similarities in properties among pairs of metallic elements and their compounds in the lower-right quadrant of the periodic table have been named the ‘knight’s move’ relationship. here, we have undertaken a systematic study of the only two ‘doublepairs’ of ‘knight’s move’ elements within this region: copper-indium/indium-bismuth and zinc-tin/tin-polonium, focussing on: metal melting points; formulas and properties of compounds; and melting points of halides and chalcogenides. on the basis of these comparisons, we conclude that the systematic evidence for ‘knight’s move’ relationships derives from similarities in formulas and properties of matching pairs of compounds in the same oxidation state. physical properties, such as melting points, do not provide consistent patterns and trends and hence should not be considered as a common characteristic of this relationship.
2007	w. h. eugen schwa rz	recommended questions on the road towards a scientific explanation of the periodic system of chemical elements with the help of the concepts of quantum physics		abstract. periodic tables (pts) are the ‘ultimate paper tools’ of general and inorganic chemistry. there are three fields of open questions concerning the relation between pts and physics: (i) the relation between the chemical facts and the concept of a periodic system (ps) of chemical elements (ces) as represented by pts; (ii) the internal structure of the ps; (iii) the relation between the ps and atomistic quantum chemistry. the main open questions refer to (i). the fuzziness of the concepts of chemical properties and of chemical similarities of the ce and their compounds guarantees the autonomy of chemistry. we distinguish between ces, elemental stuffs and elemental atoms. we comment on the basic properties of the basic elements. concerning (ii), two sharp physical numbers (nuclear charge and number of valence electrons) and two coarse fuzzy ranges (ranges of energies and of spatial extensions of the atomic orbitals, aos) characterize the atoms of the ces and determine the two-dimensional structure of the ps. concerning (iii), some relevant ‘facts’ about and from quantum chemistry are reviewed and compared with common ‘textbook facts’. what counts in chemistry is the whole set of nondiffuse orbitals in low-energy average configurations of chemically bonded atoms. decisive for the periodicity are the energy gaps between the core and valence shells. diffuse rydberg orbitals and minute spin–orbit splittings are important in spectroscopy and for philosophers, but less so in chemical science and for the ps.
2007				
2007	guiller mo restrep o	mathematical aspects of the periodic law		abstract. we review different studies of the periodic law and the set of chemical elements from a mathematical point of view. this discussion covers the first attempts made in the 19th century up to the present day. mathematics employed to study the periodic system includes number theory, information theory, order theory, set theory and topology. each theory used shows that it is possible to provide the periodic law with a mathematical structure. we also show that it is possible to study the chemical elements taking advantage of their phenomenological properties, and that it is not always necessary to reduce the concept of chemical elements to the quantum atomic concept to be able to find interpretations for the periodic law. finally, a connection is noted between the lengths of the periods of the periodic law and the philosophical pythagorean doctrine.

2007	and leonardo pacho´n			
2007	r.j. deltete	wilhelm ostwald's energetics 1: origins and motivations		
2007	claus jacob	the closure of the department of chemistry at the university of exeter – an insider's view		abstract. the closure of the school of chemistry at the university of exeter in july 2005 has terminated a traditional, and in many aspects thriving british chemistry department. the closure proceedings, which started with a four (out of five) star rating for exeter chemistry in the 2001 country-wide research assessment exercise, followed an already familiar pattern. in august 2003, the chemistry department was merged with the biology department to form the school of biological and chemical sciences. the troubled new school then conducted several embarrassing in house 'research evaluations' and ultimately decided to dismiss a large number of chemistry staff. in turn, this move triggered an exodus of most remaining chemists, leading to the de facto disappearance of the chemistry unit by the end of 2005. interestingly, the decision to close the chemistry department was based on a conglomerate of economic and strategic reasons, most of which had little to do with research performance. the closure has highlighted a dangerous dichotomy between chemists' ability to conduct excellent academic research, and their need to fulfil certain economic and strategic categories.while the closure has, perhaps ironically, demonstrated that chemistry at universities is indeed part of a wider social process, it has also exposed the severe extra-scientific constraints imposed on scientists and shattered the illusion that university scientists are free to follow positive problem shifts in their research.
2007	leo na¨pinen	the need for the historical understanding of nature in physics and chemistry		abstract. during the last decades the physico-chemical conception of self-organization of chemical systems has been created. the chemical systems in natural-historical processes do not have any creator: they rise up from irreversible processes by self-organization. the issue of self-organization in physics has led to a new interpretation of the laws of nature. as ilya prigogine has shown, they do not express certainties but possibilities and describe a world that must be understood in a historical way. in the new philosophical understanding of nature priority is not ascribed to any single type or level of entity, but to historical processes, to processes of endless generation and change.
2007	shant shahbazian and mansour zahedi	letter to the editor: the concept of chemical bond – some like it fuzzy but others concrete		in a recent paper (shahbazian and zahedi, 2006), we have discussed our viewpoint on the inherent conceptual problems regarding the role and also use and misuse of non-observables in chemical language

2008	jerom e a. berson	fundamental theories and their empirical patches	keywords merit of theories _ empirical content _ pragmatic imperatives	abstract many theories require empirical patches or ad hoc assumptions to work properly in application to chemistry. some examples include the bohr quantum theory of atomic spectra, the pauli exclusion principle, the marcus theory of the rate-equilibrium correlation, kekule's hypothesis of bond oscillation in benzene, and the quantum calculation of reaction pathways. often the proposed refinements do not grow out of the original theory but are devised and added ad hoc. this brings into question the goal of constructing theories derived from first principles and the concept of ranking the merit of theories according to their freedom from empirical contamination.
2008	g. k. vemul apalli	theories of the chemical bond and its true nature	keywords chemical bond _ linus pauling _ r. s. mulliken _ valence bond theory _molecular orbital theory	abstract two different models for chemical bond were developed almost simultaneously after the schro¨dinger formulation of quantum theory. these are known as the valence bond (vb) and molecular orbital (mo) theories. initially chemists preferred the vb theory and ignored the mo theory. now the vb theory is almost dropped out of currency. the context of discovery and linus pauling's overpowering influence gave the vb theory its initial advantage. the current universal acceptance of the mo theory is due to its ability to provide direct interpretation of many different types of experiments now being pursued. in current research both localized bonds and delocalized charge distributions play important roles and the mo theory has been successful in giving a good account of both.
2008	w. m. goodw in	implementatio n and innovation in total synthesis	keywords organic chemistry _ total synthesis _ philosophy of applied science _ philosophy of technology	abstract this article investigates how understanding the theory of organic chemistry facilitates the total synthesis of organic compounds. after locating the philosophical significance of this question within the methodology or epistemology of applied science, i summarize the results of previous work on this issue—roughly that theoretical organic chemistry underwrites a sequence of heuristic policies that help to isolate plausible synthetic routes from the array of possibilities provided by structural or descriptive organic chemistry. while this prior account makes a solid start, it does not capture all of the ways that the theory of organic chemistry contributes to total synthesis. this article aspires to enrich this account by exploring some additional ways that theory contributes. more specifically, i investigate how understanding the theory of organic chemistry can facilitate both the development of novel synthetic reactions and the implementation of a synthetic plan. the role of theory in these aspects of total synthesis will be explored by considering a particular, novel synthesis of longifolene.

2008	robert j. deltete	wilhelm ostwald's energetics 3: energetic theory and applications, part ii	keywords wilhelm ostwald _ energetics _ irreversibility _ energy in chemistry	abstract this is the third of a series of essays on the development and reception of wilhelm ostwald's energetics. the first essay described the chemical origins of ostwald's interest in the energy concept and his motivations for seeking a comprehensive science of energy. the second essay and the present one discuss his various attempts, beginning in 1891 and extending over almost 3 years, to develop a consistent and coherent energetic theory. a final essay will consider reactions to this work and ostwald's replies, and will also seek to evaluate his program of research. ostwald's project—to reconstruct physics and chemistry ''as a pure energetics''—is worth attending to for several reasons: first, because ostwald did ground-breaking work in chemistry (he was awarded a nobel prize in 1909 for his studies in catalysis and rates of reaction); second, because an important school of physical chemistry formed around him at leipzig, a school that promoted his ideas; and, finally, because he was a prominent and vigorous participant in debates at the end of the nineteenth century concerning the proper course of physical theory.
2008	santiago alvarez æ joaquim sales æ miquel seco	on books and chemical elements	keywords periodicity _ mendeleev _ chemical elements _ chemistry textbooks _ science and literature	abstract the history of the classification of chemical elements is reviewed from the point of view of a bibliophile. the influence that relevant books had on the development of the periodic table and, conversely, how it was incorporated into textbooks, treatises and literary works, with an emphasis on the spanish bibliography are analyzed in this paper. the reader will also find unexpected connections of the periodic table with the bible or the architect buckminster fuller.
2008	paul hoyningen-huene	thomas kuhn and the chemical revolution	keywords thomas kuhn _ scientific revolutions _ chemical revolution _ phlogiston theory _ significant anomalies _ world change	abstract the paper discusses how well kuhn's general theory of scientific revolutions fits the particular case of the chemical revolution. to do so, i first present condensed sketches of both kuhn's theory and the chemical revolution. i then discuss the beginning of the chemical revolution and compare it to kuhn's specific claims about the roles of anomalies, crisis and extraordinary science in scientific development. i proceed by comparing some features of the chemical revolution as a whole to kuhn's general account. the result will be that kuhn's general description of scientific revolutions fits the chemical revolution extraordinarily well. however, this result should not be taken as an empirical confirmation of kuhn's theory, but rather as an indication that the chemical revolution is a constitutive part of it.

2008	w. m. goodwin	structural formulas and explanation in organic chemistry	keywords organic chemistry _ explanation _ structural formulas _ ring strain _ potential energy diagrams	abstract organic chemists have been able to develop a robust, theoretical understanding of the phenomena they study; however, the primary theoretical devices employed in this field are not mathematical equations or laws, as is the case in most other physical sciences. instead it is diagrams, and in particular structural formulas and potential energy diagrams, that carry the explanatory weight in the discipline. to understand how this is so, it is necessary to investigate both the nature of the diagrams employed in organic chemistry and how these diagrams are used in the explanations of the discipline. i will begin this paper by characterizing some of the major ways that structural formulas used in organic chemistry. next i will present a model of the explanations in organic chemistry and describe how both structural formulas and potential energy diagrams contribute to these explanations. this will be followed by several examples that support my abstract account of the role of diagrams in the explanations of organic chemistry. in particular, i will consider both the appeal to 'hyperconjugation' in the explanation of alkene stability and how the idea of 'ring strain' was developed to explain the relative stability of cyclic compounds.
2008		liberato cardellini the views and influence of ernst von glasersfeld: an introduction	key words: ernst von glasersfeld, forms of constructivism, objectivity, constructivist theory of instruction	abstract. research into learners' ideas about science suggests that students often have alternative conceptions about important science concepts. because of this dissatisfaction, constructivism has been adopted asa theoretical framework by many teachers and researchers, and it has had a curricular influence in many countries. constructivism is much more than an educational doctrine and we are aware that a _science war' about the possibility of objectivity is in progress. _constructivism' cannot necessary be a package deal: it must be possible to accept educational suggestions deemed useful without buying all the epistemology or the metaphysical implications. the claim that cognitive agents understand the world by constructing mental representations of it can be a shared suggestion for changing science instruction. many teachers are much more concerned in finding productive teaching methods than about philosophical questions as if knowledge must be considered an objective representation of the real world or not. we have to ponder if some ideas from the constructivist theory of instruction can help instructors to become better teachers. the pragmatic suggestions that come from the constructivist theory of instruction developed by von glasersfeld, the leading proponent of radical constructivism, could be a good start in this search.
2008	hinne hettema	a note on michael weisberg's: challenges to the structural conception of chemical bonding	keywords chemical bond _ models _ quantum chemistry	abstract michael weisberg's recent 2007 paper on the chemical bond makes the claim that the chemical notion of the covalent bond is in trouble. this note casts doubts on that claim.
2008	geoff rayner-canham æ zheng zheng	naming elements after scientists: an account of a controversy	keywords periodic table _ nomenclature _ elements _ moseleyum _ curium _ seaborgium	abstract over the last two hundred years, there have been many occasions where the name of a newly-discovered element has provoked controversy and dissent but in moder n times, the naming of elements after scientists has proved to be particularly contentious. here we recount the threads of this story, predominantly through discourses in the popular scientific journals, the first major discussion on naming an element after a scientist (moseley); the first definitive naming after a scientist (curie); and the first naming after a living scientist (seaborg).

2008	rom harre´	some presuppositions in the metaphysics of chemical reactions abstract		. the project of chemistry to classify substances and develop techniques for their transformation into other substances rests on assumptions about the means by which compounds are constituted and reconstituted. robert boyle not only proposed empirical tests for a metaphysics of material corpuscules, but also a principle for designing experimental procedures in line with that metaphysics. later chemists added activity concepts to the repertoire. the logic of activity explanations in modern times involves hierarchies of activity concepts, transitions between levels through nondispositional groundings. such hierarchies terminate in powerful particulars, such as elementary charged particles. do these have a fundamental place in the most recent accounts of molecular architecture, stabilities and transformations? however, a close study of the contemporary chemistry of substances transforming reactions discloses a hybrid metaphysics, making use of both the boylean corpuscles and faradayan fields. this is illustrated by an analysis of the metaphysics inherent in john polanyi's use of 'chemoluminescence'' to follow the formation of products in chemical reactions. a brief sketch of a resolution of the tension between the two metaphysical schemes is drawn from niels bohr's radical metaphysics extended from the quantum realm proper to chemistry (and perhaps beyond).
2008	f .michael f	akeroyd mechanistic explanation versus deductivenomological explanation	key words: mechanistic explanation, deductive-nomological explanation, lavoisier, kirwan.	abstract. this paper discusses the important paper by paul thagard on the pathway version of mechanistic explanation that is currently used in chemical explanation. the author claims that this method of explanation has a respectable pedigree and can be traced back to the chemical revolution in the arguments used by the lavoisier school in their theoretical duels with richard kirwan, the proponent of a revised phlogistonian theory. kirwan believed that complex chemical reactions could be explained by recourse to affinity tables that catalogued the attraction that various simple bodies possessed towards each other. to explain was in effect to make a delayed prediction, it is not enough just to show how a phenomenon fits into the discernible patterns of the world. lavoisier, fourcroy and their colleagues used pathway reasoning, although disguising this fact by suggesting that affinities varied when subjected to n-body situations.
2008	micah newman	chemical supervenience	keywords supervenience æ chemistry æ properties æ emergence æ reduction æ explanation æ closure æ intensive æ aristotle	abstract this paper surveys some ways in which the chemical realm can be described and outlined in terms of the concept of supervenience. the particular contours of general chemical theory provide a ready basis for interpretation of determination, covariance, and nonreduction—the characteristic metaphysical facets of the supervenience relation—in mutual terms. building on this, the extent to which chemically characterized properties and entities can be described in terms of a supervenience-scaffolded structure represents a particularly vivid application that philosophers in general interested in supervenience would do well to attend to. in addition, the model of chemical supervenience given here can be used as a rubric on which to decide on issues already raised by philosophers of chemistry.

2008	ernesto paparazzo	why take chemistry stoically? the case of posidonius	keywords posidonius _ stoic philosophy _ chemical element _ chemical species _	abstract this paper analyzes views of the stoic philosopher posidonius (1st century bc) in the light of modern chemistry. i propose that posidonius' account on ''generation and destruction'' bears noteworthy similarities to the scientific notions of chemical elements, chemical species, nuclear reactions, and the law of conservation of mass. i find that his views compare favorably also with our understanding of chemical change at solid surfaces. provided his thought is correctly placed in the cultural context of his day, i argue that posidonius deserves a previously un-acknowledged consideration in the historical background of modern chemistry.
2009	jozef sˇima	oxidation number: issues of its determination and range	keywords limits in chemistry _ oxidation number range _ esca data _atomic charge _ uncertainties in oxidation number	abstract the paper is aimed at the issues of oxidation state determination and limiting values. the possibility of existence of compounds containing an atom with the oxidation number beyond the current common values, i.e., below -iv and above ?viii are discussed. three principal modes of preparation of compounds with the oxidation number exceeding viii, electrochemical anodic oxidation, photoionization, and nuclear b-decay, are evaluated. failure to prepare compounds containing an atom with the oxidation number below -iv is rationalized. the paper provides an opinion on uncertainties in oxidation state determination in three kinds of compounds: binary compounds, nitrosyl complexes, and compounds containing mutually bonded atoms of the same element. the questions are discussed from the viewpoint of correlation of ''man-made'' quantities and objective, experimentally obtainable data.
2009	hinne hettema	explanation and theory formation in quantum chemistry	keywords explanation _ theory formation _ quantum chemistry	abstract in this paper i expand eric scerri's notion of popper's naturalised approach to reduction in chemistry and investigate what its consequences might be. i will argue that popper's naturalised approach to reduction has a number of interesting consequences when applied to the reduction of chemistry to physics. one of them is that it prompts us to look at a 'bootstrap' approach to quantum chemistry, which is based on specific quantum theoretical theorems and practical considerations that turn quantum 'theory' into quantum 'chemistry' proper. this approach allows us to investigate some of the principles that drive theory formation in quantum chemistry. these 'enabling theorems' place certain limits on the explanatory latitude enjoyed by quantum chemists, and form a first step into establishing the relationship between chemistry and physics in more detail.

2009	joseph e. earley sr.	how chemistry shifts horizons: element, substance, and the essential	keywords substance _ element _ priscian _ metaphysics _ bundle theory _polysemy of chemical terms _ paneth _ elementary substance	abstract in 1931 eminent chemist fritz paneth maintained that the modern notion of ‘‘element’’ is closely related to (and as ‘‘metaphysical’’ as) the concept of element used bythe ancients (e.g., aristotle). on that basis, the element chlorine (properly so-called) is not the elementary substance dichlorine, but rather chlorine as it is in carbon tetrachloride. the fact that pure chemicals are called ‘‘substances’’ in english (and closely related words are so used in other european languages) derives from philosophical compromises made by grammarians in the late roman empire (particularly priscian [fl. *520 ce]). when the main features of the constitution of isotopes became clear in the first half of the twentieth century, the formal (iupac) definition of a ‘‘chemical element’’ was changed. the features that are ‘‘essential’’ to being an element had previously been ‘‘transcendental’’ (‘‘beyond the sphere of consciousness’’) but, by the mid-twentieth century the defining characteristics of elements, as such, had come to be understood in detail. this amounts to a shift in a ‘‘horizon of invisibility’’ brought about by progress in chemistry and related sciences. similarly,chemical insight is relevant to currently-open philosophical problems, such as the status of ‘‘the bundle theory’’ of the coherence of properties in concrete individuals.
2009	klaus ruthen berg	paneth, kant, and the philosophy of chemistry	keywords paneth _ kant, basic and simple substances _ metaphysics _ transcendental _ antirealism	abstract immanuel kant has built up a dualistic epistemology that seems to fit to the peculiarities of chemistry quite well. friedrich paneth used kant’s concept and characterized simple and basic substances which refer to the empirical and to the transcendental world, respectively. this paper takes account of the kantian influences in paneth’s philosophy of chemistry, and discusses pertinent topics, like observables, atomism and realism.
2009	rom harre	trope theory and the ontology of chemistry	keywords substance _ property _ universal _ chemistry _ trope	´abstract the traditional ontology within which chemistry has developed involved various versions of a general substance/attribute scheme. recently this has been challenged by two versions of dynamism. one version is derived from the writings of a. n. whitehead and the other from several sources, including g. leibniz and i. kant. both involve the idea of flux of actual occasions. unlike the former scheme, the latter involves a foundation of causal powers and the energetics of field theory. the situation has been made more interesting because of the revival of trope theory, based on an ontology of particularized attributes. this notion is claimed to resolve philosophical problems about the nature of universals and of substances through the introduction of spatial and temporal sequences of tropes. while trope theory seems, at first sight, to work as an attractive alternative to substance/attribute close inspection shows that it is beset with difficulties that are moreproblematic that the dynamist ontology based on casual powers, dispositions and affordances.

2009	richard m. pagni	the weak nuclear force, the chirality of atoms, and the origin of optically active molecules	keywords chiral nuclei _ b decay _ inverse b decay _ elementary particles _ four forces _ standard model _ electron and positron chirality _ theoretical calculations _ pre-biotic chemistry _ origin of life	abstract although chemical phenomena are primarily associated with electrons in atoms, ions, and molecules, the masses, charges, spins, and other properties of the nuclei in these species contribute significantly as well. isotopes, for instance, have proven invaluable in chemistry, in particular the elucidation of reaction mechanisms. elements with unstable nuclei, for example carbon-14 undergoing beta decay, have enriched chemistry and many other scientific disciplines. the nuclei of all elements have a much more subtle and largely unknown effect on chemical phenomena. all nuclei are innately chiral and, because electrons can penetrate nuclei, all atoms and molecules are likewise chiral. this article describes in considerable detail the discovery of chiral nuclei, how this unusual chirality may influence the chemical behavior of atoms and molecules, and how atomic chirality may have been responsible for the synthesis of optically active molecules in the pre-biotic world.
2009	geoff rayner-canham	isoelectronic series: a fundamental periodic property	keywords isoelectronic _ periodic table _ valence-isoelectronic _ pseudo-isoelectronic	abstract the usefulness of isoelectronic series (same number of total electrons and atoms and of valence electrons) across periods is often overlooked. here we show the ubiquitousness of isoelectronic sets by means of matrices, arrays, and sequential series. some of these series have not previously been identified. in addition, we recommend the use of the term valence-isoelectronic for species which differ in the number of core electrons and pseudo-isoelectronic for matching (n) and (n ? 10) species.
2009	n. sukumar	the chemist's concept of molecular structure	keywords molecular structure _ born–oppenheimer approximation _ jahn–teller molecules _ protein structure _ atoms in molecules _ geometric phase _ molecular similarity	abstract the concept of molecular structure is fundamental to the practice and understandingof chemistry, but the meaning of this term has evolved and is still evolving. the born–oppenheimer separation of electronic and nuclear motions lies at the heart of most modern quantum chemical models of molecular structure. while this separation introduces a great computational and practical simplification, it is neither essential to the conceptual formulation of molecular structure nor universally valid. going beyond the born–oppenheimer approximation introduces new paradigms, bringing fresh insight into the chemistry of fluxional molecules, proteins, superconductors and macroscopic dielectrics, thus opening up new avenues for exploration. but it requires that our ideas of molecular structure need to evolve beyond simple ball-and-stick-type models.

2009	james francis salmon	emergence in evolution	keywords emergence _ matter _ chemical self-organization _ thermodynamics _process metaphysics _ whitehead _ teilhard de chardin	abstract ‘‘much as i dislike the idea of ages, i think a good case can be made that science has now moved from an age of reductionism to an age of emergence, a time when the search for ultimate causes of things shifts from the behavior of parts to the behavior of the collective’’ (laughlin 2005, p. 208). this quotation by nobel laureate in physics, robert b. laughlin, in his recent book, a different universe, raises interesting scientific and philosophical issues. bench chemists continue successfully to synthesize new compounds and report results through quantitative and structural analyses of constitutive elements. the whole continues to be understood by analysis of the parts. the relatively recent science of emergence comes with a different perspective: how to explain novel, irreducible, and unpredictable appearances in cosmic evolution? new wholes seem to be more that the sum of their parts. how do these wholes come to exist? do classical concepts of matter satisfy the science of emergence? descriptions of nature’s phenomena that challenge classical interpretations of the ‘ ‘age of reductionism’’ are presented to stimulate possible new scientific and philosophical concepts for an age of reductionism and emergence.
2009	pio garcı´a	discovery by serendipity: a new context for an old riddle	keywords discovery _ combinatorial chemistry _ serendipity	abstract in the last years there has been a great improvement in the development of computational methods for combinatorial chemistry applied to drug discovery. this approach to drug discovery is sometimes called a ‘‘rational way’’ to manage a well known phenomenon in chemistry: serendipity discoveries. traditionally, serendipity discoveries are understood as accidental findings made when the discoverer is in quest for something else. this ‘traditional’ pattern of serendipity appears to be a good characterization of discoveries where ‘‘luck’’ plays a key role. in this sense, some initial failures in combinatorial chemistry are frequently attributed to a naı¨f appropriation of a ‘‘serendipity model’’ for discovery (a ‘‘serendipity mistake’’). in this paper we try to evaluate this statement by criticizing its foundations. it will be suggested that the notion of serendipity has different aspects and that the criticism to the first attempts could be understood as a ‘‘serendipity mistake.’’ we will suggest that ‘‘serendipity’’ strategies, a kind of blind search, can be seen sometimes as a ‘‘genuine part’’ of scientific practice. a discussion will ensue about how this characterization can give us a better understanding of some aspects of serendipity discoveries.
2009	richard martin pagni	the origin and development of the acidity function	keywords louis p. hammett _ acidity function _ superacid _ hydrogen ion _ proton _ activity _ activity coefficient	abstract the acidity function is a thermodynamic quantitative measure of acid strength for non-aqueous and concentrated aqueous brønsted acids, with acid strength being defined as the extent to which the acid protonates a base of known basicity. the acidity function, which was developed, both theoretically and experimentally, by louis p. hammett of columbia university during the 1930s, has proven useful in the area of physical organic chemistry where it has been used to correlate rates of acid-catalyzed reactions and to quantitate the acidity of superacids, acids with protonating abilities greater than pure sulfuric acid. all brønsted acids can now be compared using a common measure. karl popper’s seminal idea of theory falsification does not apply here because of the many successful applications of the acidity function. likewise, thomas kuhn’s idea of a paradigm shift does not apply here, even though the acidity function concept was revolutionary, because the acidity function is commensurate with classical concepts of acidity.

2009	meredith tromble	the advent of chemical symbolism in the art of sonya rapoport	keywords alchemy _ art _ chemistry _ cobalt _ digital art _ drawing _ feminism _ gold _ lederer _ new media _ nuclear chemistry _ periodic table _ rapoport _ scientific illustration	abstract this paper explores the use of chemical symbolism in works by the new media artist sonya rapoport, with a focus on the pivotal cobalt series from the late 1970s. these works, drawings on computer printouts generated by research at the lawrence berkeley laboratory, respond to experiments in nuclear chemistry. they mark the beginning of three productive decades in which rapoport produced a variety of images related to chemistry in her work. she states, ‘‘i looked for authentic research projects that were interesting to me, preferably with captivating pictorial subject matter. then came the creative chaotic process of resolving a cohesive product that combined scientific research with art concept.’’ rapoport had an unusual degree of access to scientific materials through her husband, organic chemist henry rapoport, a faculty member at the university of california, berkeley. at the time of production, these works were outside mainstream art world interests and they have received little critical attention. this paper examines the development of rapoport’s images and places her use of chemical references in context in her lifetime of work.
2010	gordon t. Woods	mendeleev, the man and his matrix: dmitri mendeleev, aspects of his life and work: was he a somewhat fortunate man?	keywords mendeleev , periodic table , prediction-accommodation, nobel chemistry prize , tobol’sk ,william ramsay , de boisbaudron , de chantcourtois , kamensky , gallium, bohuslav brauner	abstract this article traces the life of russian chemist dmitri mendeleev from childhood in siberia, through education and training to become the first formulator of the periodic table, the logo of chemistry. his unique contribution is described and analysed; what factors helped him be the first formulator? what did he do after making his most famous discovery? in addition the article peeps into his personal life, his dealings with his family and the authorities. finally we look at honours he received in later life.
2010	gary d. Patterson	les atomes: a landmark book in chemistry	keywords atoms _ brownian motion _ jean perrin _ atomic doctrine	abstract there have been occasions when the publication of a particular book has had a singular impact on the conceptual world of the chemist. sometimes the publication occurs near the beginning of a major change in discourse, and sometimes more near the end. jean perrin published les atomes in 1913 as the culmination of a century-long controversy over the size and physical reality of atoms and molecules. after its publication almost all chemists and physicists agreed that atoms and molecules of the size we currently understand to be appropriate are real physical objects. the story of the background, development, publication, content and response to les atomes forms the text of this paper. the content of les atomes is also the basis for extended reflection on the philosophical significance of the work of jean perrin.

2010	rom harre	causal concepts in chemical vernaculars	keywords hume _ kant _ causality _ powerful particular _ regularity _ events _ agency	abstract though causality seems to have a natural place in chemical thought, the analysis of the underlying causal concepts requires attention to two different research styles. in part one i attempt a classification and critical analysis of several philosophical accounts of causal concepts which appear to be very diverse. i summarize this diversity which ranges from causality as displayed in regular concomitances of types of events to causality as the activity of agents. part two is concerned with the analysis of contrasting chemical discourses, comparing the classical atomist style of boyle, and lavoisier and von liebig with the later energeticist style of van't hoff and hinshelwood. in detail different clusters of causal concepts can be abstracted from these discursive styles, yet they all approximate the realist format for causal discourse. by way of summary i make an attempt to map the vernacular distinctions of part two onto the philosophical territory of part one. the argument is rounded off with a brief analysis of a chemical publication of 2008.
2010	michael akeroyd	the philosophical significance of mendeleev's successful predictions of the properties of gallium and scandium	keywords corroboration _ predictions _ triads	abstract the philosophical significance of dmitri mendeleev's successful predictions of the properties of gallium and scandium vis a vis the acceptance of the periodic table 1874–1886 has been debated recently. this author presents evidence that de boisbaudran and cleve both respectively predicted the possible existence of gallium and scandium, but on the basis of the old triad methodology. this suggests that these successful mendeleev predictions were therefore not independent corroboration of the concept of the periodic system. instead the significantly independent predictive successes for mendeleev's system were (a) the determination of the atomic weight of the known element uranium as 240 instead of the previously accepted 120 in 1874 and (b) the isolation of germanium by winkler in 1886.
2010	j. van brakel	chemistry and physics: no need for metaphysical glue	keywords chemistry and physics _ reduction _ supervenience _ part-whole _ceteris paribus laws _ interdiscourse relations	abstract using the notorious bridge law ''water is h2o'' and the relation between molecular structure and quantum mechanics as examples, i argue that it doesn't make sense to aim for specific definition(s) of intertheoretical or interdiscourse relation(s) between chemistry and physics (reduction, supervenience, what have you). proposed definitions of interdiscourse and part-whole relations are interesting only if they provide insight in the variegated interconnected patchwork of theories and beliefs. there is ''automatically'' some sort of interdiscourse relation if different discourses claim to have something to say about the same situation (event, system), which is the basis of (contingent) local supervenience relations, which, proper empirically support being provided, can be upgraded to ceteris paribus bridge laws. because of the ceteris paribus feature, and the discourse dependence of event identification, there is at best only global supervenience of the ''special sciences'' on the physical (and of parts of physics on other parts of physics).
2010	jens soentgen	on the history and prehistory of co2	keywords carbon dioxide _ gas _ history of science _ history of religion _global warming _ greenhouse gas	abstract i will trace the little known prehistory and parts of the better known history of co2 by investigating some of the names it has been given from antiquity to the present day. in antiquity, the words pneuma or spiritus letalis designated both a supernatural force and an exhalation that emanated from certain caves. we will see how co2 gradually came to be regarded as something natural, a gas and then substance.

2010	martı´ n labarc a • olimpi a lomba rdi	why orbitals do not exist?	keywords orbital _ wavefunction _ molecular chemistry _ quantum mechanics	abstract in this paper we will address the problem of the existence of orbitals by analyzing the relationship between molecular chemistry and quantum mechanics. in particular, we will consider the concept of orbital in the light of the arguments that deny its referring character. on this basis, we will conclude that the claim that orbitals do not exist relies on a metaphysical reductionism which, if consistently sustained, would lead to consequences clashing with the effective practice of science in its different branches.
2010	olimpi a lomba rdi • mario castag nino	matters are not so clear on the physical side	keywords molecular chemistry _ quantum mechanics born-oppenheimer approximation _ quantum ontology	abstract according to ontological reductionism, molecular chemistry refers, at last, to the quantum ontology; therefore, the ontological commitments of chemistry turn out to be finally grounded on quantum mechanics. the main problem of this position is that nobody really knows what quantum ontology is. the purpose of this work is to argue that the confidence in the existence of the physical entities described by quantum mechanics does not take into account the interpretative problems of the theory: in the discussions about the relationship between chemistry and physics, difficulties are seen only on the side of chemistry, whereas matters highly controversial on the side of physics are taken for granted. for instance, it is usually supposed that the infinite mass limit in the born-oppenheimer approximation leads by itself to the concept of molecular framework used in molecular chemistry. we will argue that this assumption is implicitly based on an interpretative postulate for quantum mechanics, which, in turn, runs into difficulties when applied to the explanation of the simplest model of the hydrogen atom.
2010	philip j. stewar t	charles janet: unrecognized genius of the periodicsyste m	keywords janet _ periodic system _ tables _ spiral representations _antimatter _ madelung rule	abstract janet is known almost exclusively for his left-step periodic table (lspt). a study of his writings shows him to have been a highly creative thinker and a brilliant draftsman. his approach was primarily arithmetic-geometric, but it led him to anticipate the discovery of deuterium, helium-3, transuranian elements, antimatter and energy from nuclear fusion. he recognized the (n ? ‘) rule well before madelung and correctly placed the actinides. his controversial treatment of helium at the head of the alkaline earth elements might be less provocative if his system were taken in one of its spiral representations.
2010	w. p. griffit h	the group viii platinum-group metals and the periodic table	keywords periodic table _ platinum _ ruthenium _ rhodium _ palladium _ osmium _ iridium _ mendeleev	abstract the six platinum group metals (pgms: ruthenium, rhodium, palladium, osmium, iridium and platinum) posed a number of problems for 19th-century chemists, including mendeleev, for their periodic classification. this account discusses the discovery of the pgms, the determination of their atomic weights and their classification.
2010	m. j. laing	the question mark at uranium		abstract being excerpts from pages 187, 203, 204, 207, 208, 209, 210 and 211 of uncle tungsten, extracted by michael laing with the consent of the author, professor oliver sacks, and picador publishers.

2010	fathi habashi	metals: typical and less typical, transition and inner transition	keywords typical metals _ less typical metals _ transition metals _inner transition metals _ iupac numbering _ group names	abstract while most chemists agree on what is a metal and what is a non-metal there is a disagreement with respect to what is a metalloid and what is a transition metal. it is believed that this problem can be solved if two new terms are adopted: typical and less typical metals. these new terms will also help reconcile the european periodic table versus the north american regarding numbering of groups as well as the iupac numbering which could be as well abandoned in favour of group names as will be shown in the manuscript.
2010	emma tobin	microstructuralism and macromolecules: the case of moonlighting proteins	keywords natural kinds, microstructuralis macromolecules, polymer protein, essentialism ,moonlighting protein	abstract microstructuralism in the philosophy of chemistry is the thesis that chemical kinds can be individuated in terms of their microstructural properties (hendry in philos sci73:864–875, 2006). elements provide paradigmatic examples, since the atomic number should suffice to individuate the kind. in theory, microstructuralism should also characterize higher-level chemical kinds such as molecules, compounds, and macromolecules based on their constituent atomic properties. in this paper, several microstructural theses are distinguished. an analysis of macromolecules such as moonlighting proteins suggests that all the forms of microstructuralism cannot accommodate them.
2010	j. a. linthorst	an overview: origins and development of green chemistry	keywords green chemistry _ history of chemistry _ pollution prevention act of 1990 _ us epa	abstract this article provides an overview of the origins and development of green chemistry. aiming to contribute to the understanding of green chemistry, basically from a historical point of view, this overview argues that contextual influences and the user friendliness of the term are drivers for the explosive growth of green chemistry. it is observed that political support for its development has been significant, in which the pollution prevention act of 1990 was a formal political starting-point, but informally the origins of green chemistry go back to before 1990. us epa played an important role in all this, but did not solely contribute to the growth of green chemistry.
2010	eric scerri e. scerri (&)	explaining the periodic table, and the role of chemical triads	keywords chemistry _ quantum mechanics _ periodic table _ information theory _chemical triads	abstract some recent work in mathematical chemistry is discussed. it is claimed that quantum mechanics does not provide a conclusive means of classifying certain elements like hydrogen and helium into their appropriate groups. an alternative approach using atomic number triads is proposed and the validity of this approach is defended in the light of some predictions made via an information theoretic approach that suggests a connection between nuclear structure and electronic structure of atoms.
2010	e. g. marks • j. a. marks	newlands revisited: a display of the periodicity of the chemical elements for chemists	keywords periodic table _ newlands	abstract this is a periodic table explicitly for chemists rather than physicists. it is derived from newlands' columns. it solves many problems such as the positions of hydrogen, helium, beryllium, zinc and the lanthanoids but all within a succinct format.

2011	rom harre´ • jean-pierre llored	mereologies as the grammars of chemical discourses	keywords part—whole _ atom _ moelcule _ set _ ion _ affordance _ mass substances	_ abstract mereology is the logic of part—whole concepts as they are used in many different contexts. the old chemical metaphysics of atoms and molecules seems to fit classical mereology very well. however, when functional attributes are added to part specifications and quantum mechanical considerations are also added, the rules of classical mereology are breached in chemical discourses. a set theoretical alternative mereology is also found wanting. molecular orbital theory requires a metaphysics of affordances that also stands outside classical mereology.
2011	rom harre´ • jean-pierre llored	mereologies as the grammars of chemical discourses	keywords part—whole _ atom _ moelcule _ set _ ion _ affordance _ mass substances	abstract mereology is the logic of part—whole concepts as they are used in many different contexts. the old chemical metaphysics of atoms and molecules seems to fit classical mereology very well. however, when functional attributes are added to part specifications and quantum mechanical considerations are also added, the rules of classical mereology are breached in chemical discourses. a set theoretical alternative mereology is also found wanting. molecular orbital theory requires a metaphysics of affordances that also stands outside classical mereology.
2011	r. garth kidd	elements of the third kind and the spin-dependent chemical force	keywords homomeric molecule _ pseudo-element _ protochemical atom _ atomic spin _ chemical force _ enthalpy index	abstract a lively philosophical debate has lately arisen over the nature of elementhood in chemistry. two different senses in which the technical term element is currently in use by chemists have been identified, leaving chemistry open to the logical fallacy of equivocation. this paper introduces a third, more elemental candidate: the high-enthalpy short-lived unbonded atom. an enthalpy index based on free-atoms-as-elements is established, whereby one can monitor the degree to which an atom's spin-based attractive force is implemented exo-enthalpically when the atom binds chemically to others. enthalpy indexing shows that the strength of an atom's att ractive force is proportional to its spin angular momentum. vibrational spectroscopy shows that the force varies inversely as the fourth power of the inter-atom distance. both features differentiate the chemical force from the stronger electromagnetic force and from the weaker van der waals force.
2011	rein vihale mm	the autonomy of chemistry: old and new problems	keywords autonomy of chemistry _ metaphysics _ natural kinds _ ontology _ practical realism _ reduction of chemistry to physics	abstract the autonomy of chemistry and the legitimacy of the philosophy of chemistry are usually discussed in the context of the issue of reduction of chemistry to physics, and defended making use of the failure of reductionistic claims. until quite recent times a rather widespread viewpoint was, however, that the failure of reductionistic claims concerns actually epistemological aspect of reduction only, but the ontological reduction of chemistry to physics cannot be denied. the new problems of the autonomy of chemistry in the context of reductionism seem to be ontological and metaphysical. in the present paper it is argued that there is no need for some kind of metaphysical-ontological underpinning for rejection of the secondary positions of chemistry and philosophy of chemistry with respect to physics and philosophy of physics. the issue can be elucidated in terms of the philosophy of science accepting practical realism (also known by other names).

2002	rosária s. justi	philosophy of chemistry in university chemical education: the case of models and modelling		abstract. if chemistry is to be taught successfully, teachers must have a good *subject matter knowledge* (sk) of the ideas with which they are dealing, the nature of this falling within the orbit of philosophy of chemistry. they must also have a good *pedagogic content knowledge* (pck), the ability to communicate sk to students, the nature of this falling within the philosophy and psychology of chemical education. taking the case of models and modelling, important themes in the philosophy of chemistry, an interview-based study was conducted into the sk and pck of a sample of teachers in brazil. this paper focuses on the results of the university chemistry teacher sub-sample in that enquiry, analyses their sk and pck, and speculates on the implications of this for the education of schoolteachers. finally, it suggests approaches to the professional development of university chemistry teachers that place an emphasis on the philosophy of chemistry.
2002	and john k. gilbert	john k. gilbert *school of education the university of reading u.k. e-mail: j.k.gilbert@reading.ac.uk*		abstract. if chemistry is to be taught successfully, teachers must have a good *subject matter knowledge* (sk) of the ideas with which they are dealing, the nature of this falling within the orbit of philosophy of chemistry. they must also have a good *pedagogic content knowledge* (pck), the ability to communicate sk to students, the nature of this falling within the philosophy and psychology of chemical education. taking the case of models and modelling, important themes in the philosophy of chemistry, an interview-based study was conducted into the sk and pck of a sample of teachers in brazil. this paper focuses on the results of the university chemistry teacher sub-sample in that enquiry, analyses their sk and pck, and speculates on the implications of this for the education of schoolteachers. finally, it suggests approaches to the professional development of university chemistry teachers that place an emphasis on the philosophy of chemistry
2005	joseph e. earley	why there is no salt in the sea1		abstract. what, precisely, is ‘salt’? it is a certain white, solid, crystalline, material, also called sodiumchloride.does any of that solid white stuff exist in the sea? – clearly not. one can make salt from sea water easily enough, but that fact does *not* establish that salt, as such, is present in brine. (paper and ink can be made into a novel – but no novel actually exists in a stack of blank paper with a vial of ink close by.) when salt dissolves in water, what is present is no longer ‘salt’ but rather a collection of hydrated sodium cations and chloride anions, neither of which is precisely salt, nor is the collection. the aqueous material in brine is also significantly different from pure water. salt may be considered to be present in seawater, but only in a more or less vague ‘potential’ way. actually, there is no salt in the sea. in both ancient and modern treatments of other important chemical concepts, including the notions of ‘element’, related complication, especially polysemy (terms with multiple meanings), also occurs.
2000	pierre duhem	atomic notation and atomistic hypotheses		*translated by paul needham* this article was first published as “**notation atomique et hypotheses atomistiques**”, *revue des questions scientifiques*, 31 (1892), 391–457. it is the second of a series of articles duhem was to publish in the catholic journal *revue des questions scientifiques*, in which he presents his understanding of what can justifiably be said about the structure of chemical substances as captured by chemical formulas. the argument unfolds following a broadly historical development of events throughout the cour

	octavio novaro	on the rightful place for he within the periodic table	keywords periodic table _ nonadditivity _ he _ be	abstract many different arguments have been put forward in order to assign the best place for a given element within mendeleev's table: its spectroscopy, its chemical activity, the crystalline structure of its solid state, etc. we here propose another criterion; the nature of the few body corrections to the pairwise additive energy. this argument is used here to address a question often brought forward by eric scerri in foundations of chemistry, namely the rightful place of helium; either above the column of the alkaline earths (beryllium, etc.) or rather above the noble gas elements.
	f.a. paneth	the epistemological status of the chemical concept of element_		discussions of the principal concepts of chemistry are few and superficial, in striking contrast to the many penetrating investigations into the philosophic foundations of physical theories. in previous centuries there was an obvious reason for this: many physical doctrines were already common knowledge amongst the educated, whilst chemistry, in the scientific sense, did not exist at all, or was only just beginning
1999	pierre laszlo	circulation of concepts		abstract. a major obstacle to chemistry being a deductive science is that its core concepts very often are defined in a circular manner: it is impossible to explain what an acid is without reference to the complementary concept of a base. there are many such dual pairs among the core concepts of chemistry. such circulation of concepts, rather than an infirmity chemistry is beset with, is seen as a source of vitality and dynamism.
2000	p.h.a. sneath	numerical classification of the chemical elements and its relation to the periodic system		abstract. a numerical classification was performed on 69 elements with 54 chemical and physicochemical properties. the elements fell into clusters in close accord with the electron shell *s*-, *p*- and *d*-blocks. the *f*-block elements were not included for lack of sufficiently complete data. the successive periods of *s*- and *p*-block elements appeared in an oval configuration, with *d*-block elements lying to one side. more than three axes were required to give good representation of the variation, although the interpretation of the higher axes is difficult. only 15 properties were scorable for the noble gases, but despite the paucity of properties reflecting chemical reactivity, analysis of the 69 elements on these properties still showed the major features seen from the full set.
2001	s. le vent	what is a perfect gas mixture?		abstract. the definition of a perfect gas mixture varies substantially within the chemistry textbook literature. a recent international union of pure and applied chemistry (iupac) definition is here criticised as being insufficient to cover properties traditionally associated with such mixtures. possible supplements to the definition to rectify the deficiency are considered. an alternative definition in molecular terms is shown to be comprehensive. the paper should serve as a summary of the properties of a perfect gas mixture and of *essential* components of its definition.
2001	carmen j. giunta	argon and the periodic system: the piece that would not fit		abstract. the discovery of the noble gases and their incorporation into the periodic system are examined in this paper. a chronology of experimental reports on argon and helium and the properties relevant to their nature and position in the periodic system is presented. proposals on the nature of argon and helium that appeared in the aftermath of their discovery are examined in light of the various empirical and theoretical considerations that supported and contradicted them. "the piece that would not fit" refers not only to argon, the element that at first seemed not to fit into the periodic system, but also to the piece or pieces of evidence that various researchers and observers were prepared to discard or discount in coming to terms with the newly discovered gases.

2001	v. n. ostrov sky	what and how physics contributes to understanding the periodic law		abstract. the current status of explanation worked out by physics for the periodic lawis considered from philosophical andmethodological points of view. the principle gnosiological role of approximations and models in providing interpretation for complicated systems is emphasized. the achievements, deficiencies and perspectives of the existing quantum mechanical interpretation of the periodic table are discussed. the mainstream *ab initio* theory is based on analysis of selfconsistent one-electron effective potential. alternative approaches employing symmetry considerations and applying group theory usually require some empirical information. the approximate dynamic symmetry of one-electron potential casts light on the secondary periodicity phenomenon. the periodicity patterns found in various multiparticle systems (atoms in special situations, atomic nuclei, clusters, particles in the traps, etc) comprise a field for comparative study of the periodic laws found in nature.
2002	mark eberha rt	quantum mechanics and molecular design in the twenty first century		abstract. it is argued that the conventional descriptions of chemical bonds as covalent, ionic, metallic, and van der waals are compromising the usefulness of quantum mechanics in the synthesis and design of new molecules and materials. parallels are drawn between the state of chemistry now and when the idea that phlogiston was an element impeded the development of chemistry. overcoming the current obstacles will require newmethods to describe molecular structure and bonding, just as new concepts were needed before the phlogiston theory could be set aside.
2002	klaus hentsc hel	why not one more imponderable ? john william draper's tithonic rays	key words: arguments for and against independent entities, electromagnetic spectrum, heat, john william draper, optics, phosphorescence, tithonic rays	abstract. this paper reconstructs what may have led the american professor of chemistry and natural philosophy johnwilliam draper to introduce a new kind of radiation, which he dubbed 'tithonic rays'. after presenting his and earlier empirical findings on the chemical action of light in section 3, i analyze his pertinent papers in section 4 with the aim of identifying the various *types* of arguments he raised in favor of this new actinic entity (or more precisely, this new natural kind of ray besides optical, thermal and perhaps also phosphorogenic rays). from a modern perspective, all of these obviously belong within the electromagnetic spectrum, but not so for many thinkers of the 19th century. i close with remarksabout why draper's interpretation was abandoned in the second half of the 19^{th} century (he himself recanting only in 1872), and why i think such a natural history of argumentation (as one might call my approach in section 4) may be useful for a comparison-oriented history of science.
2003	masan ori kaji	mendeleev's discovery of the periodic law:the origin and the reception		abstract. this paper addresses the conceptual as well as social origins of mendeleev's discovery of the periodic law and its reception by the chemical community by taking account of three factors: mendeleev's early research and its relevance to the discovery; his concepts of chemistry, especially that of the chemical elements; and the social context of the discovery and the reception in the chemical community.mendeleev's clear distinction between abstract elements and simple bodies was a departure from lavoisier's famous definition of elements as an endpoint of analysis and originated from his research in unidentified compounds. as a comparison, the paper also analyzes lothar meyer's approach to the classification of the elements.mendeleev's new concept of chemical elements and the existence of an audience in the form of the newly established russian chemical society, and his "german connection", helped mendeleev in his discovery and its reception.

2003	r. vihalemm	are laws of nature and scientific theories peculiar in chemistry? scrutinizing mendeleev's discovery		abstract. the problem of the peculiar character of chemical laws and theories is a central topic in philosophy of chemistry. one of the most characteristic and, at the same time, most puzzling examples in discussions on chemical laws and theories is mendeleev's periodic law. this law seems to be essentially different in its nature from the exact laws of classical physics, the latter being usually regarded as a paradigm of science by philosophers. in this paper the main arguments concerning the peculiar character of chemical laws and theories are examined. the laws of chemistry are natural laws to the same extent as are the laws of physics. the law discovered by mendeleev is a normal law of nature. it is not a law of physics, nevertheless, it is exact in the same philosophical sense as are the laws of physics. the periodic system of chemical elements was established by constructing an idealized system of idealized elements. the fundamental idealization substantiated by experimental chemistry was the *chemical element* as a *place in the periodic system*
2003	keith s. Taber	the atom in the chemistry curriculum: fundamental concept, teaching model or epistemological obstacle?	atomic theory, chemical education, chemical ontology, epistemological obstacles, teaching models	abstract. research into learners' ideas about science suggests that school and college students often hold alternative conceptions about 'the atom'. this paper discusses why learners acquire ideas about atoms which are incompatible with the modern scientific understanding. it is suggested that learners' alternative ideas derive – at least in part – from the way ideas about atoms are presented in the school and college curriculum. in particular, it is argued that the atomic concept met in science education is an incoherent hybrid of historical models, and that this explains why learners commonly attribute to atoms properties (such as being the constituent particles of all substances, or of being indivisible and conserved in reactions) that more correctly belong to other entities (such as molecules or sub-atomic particles). bachelard suggested that archaic scientific ideas act as 'epistemological obstacles', and here it is argued that anachronistic notions of the atom survive in the chemistry curriculum. these conceptual fossils encourage learners to develop an 'atomic ontology' (granting atoms 'ontological priority' in the molecular model of matter); to make the 'assumption of initial atomicity'when considering chemical reactions; and to develop an explanatory framework to rationalise chemical reactions which is based on the desirability of full electron shells. these ideas then act as impediments to the development of a modern chemical perspective on the structure of matter, and an appreciation of the nature of chemical changes at the molecular level. ucation
2003	michael akeroyd	*letter to the editor* predictions, retrodictions and the periodic table		in a recent issue, in editorial comment on an article about mendeleef by nathan brooks (2002), eric scerri (2002) stated "then there is the question of the relative value of prediction and accommodations in the acceptance of a new scientific development which many authors in history and philosophy of chemistry have considered" (brush, 1996; scerri and worrall, 2001). this letter is to inform the journal readership of both earlier work and also more recent developments in the debate

2004	kennet h b. wiber g	strain, structure, stability and reactivity		studies of the related subjects of strain, structure, stability and reactivity represent one of the major areas of chemistry. the other is concerned with synthesis, or the preparation of molecules having specific structures. at the beginning, i will give brief definitions of these concepts, and then each will be examined in the context of the chemistry of small rings. they are compounds that contain three of four membered rings, and frequently have properties quite different than compounds that have larger rings. these differences in properties force us to think in more detail about the concepts indicated above.
2005	v. n. ostrov sky	on recent discussion concerning quantum justification of the periodic table of the elements		abstract. the recent exchange on the quantum justification of the periodic system of the elements in this journal between scerri [foundations of chemistry 6: 93–116, 2004] and friedrich [foundations of chemistry 6: 117–132, 2004] is supplemented by some methodological comments.
2005	octavi o novar o_	activity of closed d-shells in noble metal atoms		abstract. the periodic table has the column of the noble gas atoms (he, ne, ar, kr, xe, rn) as one of its main pillars. indeed the inert chemical nature of their closed shell structure is so striking that it is sometimes extended to all such structures. is it true however that any closed shell, say a closed d-subshell will denote a lack of chemical activity? take the noble metals for instance, so renowned for their catalytic capacity. platinum has 10 electrons in its valence shell which makes one of its excited states to be a closed 5d10–6s0 state. surely this state would not be expected to be crucial to the catalytic activity of platinum, or would it? or take palladium whose ground state is precisely the 4d10–5s0 state, should we expect that an isolated pd atom at near zero-point temperature would attack a closed-shell hydrogen molecule efficiently? we shall here show that this is precisely the case; the closed-shell excited states of nickel and platinum are indeed crucial, through symmetry avoided crossings, for their reactivity. other valuable catalysts as ruthenium depend on their excited states with maximal d-shell occupancy for their activity. the most notable confirmation of this new finding; that closed d-shells are vital to the catalytic activity of noble metals however, is the case of palladium whose closed-shell ground state is indeed capable of attacking hydrogen and hydrocarbon molecules even at temperatures well below 10 k as was predicted theoretically and immediately confirmed experimentally
2005	rom harré	chemical kinds and essences revisited		abstract. the philosophical problem of the utility and meaning of essences for chemistry cannot be resolved by wittgenstein's principle that essence cannot explain use, because use is displayed in a field of family resemblances. the transition of chemical taxonomy from vernacular and mystical based terms to theory based terms stabilized as a unified descriptive taxonomy, removes chemical discourse from its connection with the vernacular. the transition can be tracked using the lockean concepts of real and nominal essences, and the changing priorities between them. analyzing properties dispositionally, initiating a search for groundings strengthens the case for a logical asymmetry between descriptive and explanatory discourses. taxonomy is now driven by explanatory concepts but not including those from quantum chemistry.

2005	robin findlay hendry	lavoisier and mendeleev on the elements		abstract. lavoisier defined an element as a chemical substance that cannot be decomposed using current analytical methods. mendeleev saw an element as a substance composed of atoms of the same atomic weight. these 'definitions' do quite different things: lavoisier's distinguishes the elements from the compounds, so that the elements may form the basis of a compositional nomenclature; mendeleev's offers a criterion of sameness and difference for elemental substances, while lavoisier's does not. in this paper i explore the historical and theoretical background to each proposal. lavoisier's and mendeleev's explicit conceptions of elementhood differed fromeach other, and from the official iupac definition of 'element' of the 1920s. however, lavoisier and mendeleev both subscribed to – and employed – a deeper notion of a chemical element as the component of compound substances that (i) can survive chemical change, and (ii) explains the chemical behaviour of its compounds
2005	joseph simonian	the paradoxes of chemical classification: why 'water is h2o' is not an identity statement		abstract. a puzzle for identity statements using mass nouns, central to the expression of chemical types, arises if one accepts that both 'water is h2o' and 'ice is h2o' are identity statements, since they jointly entail that 'water is ice'. the puzzle is resolved if it can be shown that the 'is' of such statements is not the 'is' of identity.
2005	j. van brakel	on the inventors of xyz		abstract. in this paper i try to make as much sense as possible of, first, the extensive philosophical literature concernedwith the status of 'water is h2o' and, second, the implications of putnam's invention of twin earth, another possible world stipulated to be just like earth, except that water is xyz, not h2o.
2005	paul needham	mixtures and modality		abstract. some points are made about substance properties in their role of introducing mass terms. in particular, two conditions of distributivity and cumulativity of mass predicates expressing these properties are not the independent pair they first appear to be. a classification of macroscopic substance concepts is developed. this needs to be complemented in some way by the introduction of a modal qualification reminiscent of aristotle's distinction between actual and potential presence of substances in a mixture. consideration of the latter feature has prompted joe earley to raise the question of whether there is any salt in the sea. i try to argue that there is.
2006	m. f. sharlow	chemical elements and the problem of universals	key words: element, ontology, universals, abstract objects	abstract. in this paper, i explore a seldom-recognized connection between the ontology of abstract objects and a current issue in the philosophy of chemistry. specifically, i argue that realism with regard to universals implies a view of chemical elements similar to f.a. paneth's thesis about the dual nature of the concept of element.
2006	lawrence j. sacks	concerning the position of hydrogen in the periodic table		abstract. the placement of hydrogen in the periodic table has uniqueimplications for fundamental questions of chemical behavior. recentarguments in favor of placing hydrogen either separately at the top of thetable or as a member of the carbon family are shown to have serious defects.a coulombic model, in which all compounds of hydrogen are treated ashydrides, places hydrogen exclusively as the first member of the halogenfamily and forms the basis for reconsideration of fundamental concepts inbonding and structures. the model provides excellent descriptive and predictive ability for structures and reactivities of a wide range of substances.

2006	paul needham	ontological reduction: a comment on lombardi and labarca		abstract. in a recent article in this journal (foundations of chemistry, 7 (2005), 125–148) lombardi and labarca call into question a thesis of ontological reduction to which several writers on reduction subscribe despite rejecting a thesis of epistemological reduction. lombardi and labarca advocate instead a pluralistic ontology inspired by putnam's internal realism. i suggest that it is not necessary to go so far, and that a more critical view of the ontological reduction espoused by the authors they criticize circumvents the need to resort to their radical alternative.
2007	maurice r. kibler	from the mendeleev periodic table to particle physics and back to the periodic table	keywords atomic and sub-atomic physics _ group theory _ flavor group _	abstract we briefly describe in this paper the passage from mendeleev's chemistry (1869) to atomic physics (in the 1900's), nuclear physics (in 1932) and particle physics (from 1953 to 2006). we show how the consideration of symmetries, largely used in physics since the end of the 1920's, gave rise to a new format of the periodic table in the 1970's. more specifically, this paper is concerned with the application of the group so(4,2)_su(2) to the periodic table of chemical elements. it is shown how the madelung rule of the atomic shell model can be used to set up a periodic table that can be further rationalized via the group so(4,2)_su(2) and some of its sub-groups. qualitative results are obtained from this nonstandard table.
2007	philip j. stewart	a century on from dmitrii mendeleev: tables and spirals, noble gases and nobel prizes	keywords mendeleev _ periodic system _ tables _ spiral representations _ element of atomic number zero _ chemical education	abstract mendeleev's failure to represent the periodic system as a continuum may have hidden from him the space for the noble gases. a spiral format might have revealed the significance of the wide gaps in atomic mass between his rows. tables overemphasize the division of the sequence into 'periods' and blocks. not only do spirals express the continuity; in addition they are more attractive visually. they also facilitate a new placing for hydrogen and the introduction of an 'element of atomic number zero'.
2007	sibel erduran	breaking the law: promoting domain-specificity in chemical education in the context of arguing about the periodic law	keywords domain-specificity _ argumentation _ chemical laws _ periodicity	abstract in this paper, domain-specificity is presented as an understudied problem in chemical education. this argument is unpacked by drawing from two bodies of literature: learning of science and epistemology of science, both themes that have cognitive as well as philosophical undertones. the wider context is students' engagement in scientific inquiry, an important goal for science education and one that has not been well executed in everyday classrooms. the focus on science learning illustrates the role of domain specificity in scientific reasoning. the discussion on epistemology of science presents ideas from the emerging field of philosophy of chemistry to highlight the much neglected area of epistemology in chemical education. domain-specificity is exemplified in the context of chemical laws, in particular the periodic law. the applications of the discussion for chemical education are explored in relation to argumentation, itself an epistemologically grounded discourse pattern in science. the overall implications include the need for reconceptualization of the nature of teaching and learning in chemistry to include more particular epistemological aspects of chemistry.
2003	markus reiher	the systems-theoretical view of chemical concepts		abstract. while the principal ideas of a systems theory for the molecular sciences have been introduced in part i (reiher, 2003), illustrative examples for the ingredients of this systems chemistry are discussed in greater detail in this work. the potential wealth of systems chemistry is then demonstrated for a recently developed approach for the calculation of hydrogen bond energies in non-decomposable systems.

2001	charles seibert	charley peirce's head start in chemistry		abstract. as a youngster of perhaps 8 years, charles s. peirce was given a chemistry laboratory in which he probably did experiments in qualitative analysis. these experimentsweremodeled on the hypothetico-deductivemethod of inquiry. i argue that this laboratory experience initiated peirce's life-long interest in logic and the logic of science, and flowered in his "pragmaticism."
2001	ursula klein	berzelian formulas as paper tools in early nineteenth-century chemistry		abstract. this paper studies the semiotic, epistemological and historical aspects of berzelian formulas in early nineteenth-century organic chemistry. i argue that berzelian formulas were enormously productive 'paper tools' for representing chemical reactions of organic substances, and for creating different pathways of reactions. moreover, my analysis of jean dumas's application of berzelian formulas to model the creation of chloral from alcohol and chlorine exemplifies the role played by chemical formulas in conceptual development (the concept of substitution). studying the dialectic of chemists' collectively shared goals and tools, i argue that paper tools, like laboratory instruments, are resources whose possibilities are not exhausted by scientists' attempts to achieve existing goals, but rather whose applications generate new goals. the term 'paper tools' is introduced to emphasize that the pragmatic and syntactic aspects of symbolsystems are fully comparable to physical laboratory tools. 1
2002	pedro cintas	on the origin of tetrahedral carbon: a case for philosophy of chemistry?		abstract. this essay analyzes the historical and philosophical context that led to the basic concepts of stereochemistry proposed by van't hoff and le bel. although it is now well established that the key idea of tetrahedral carbon, and in general a geometric view of matter, was pioneered by other chemists, van't hoff and le bel used this idea to solve the puzzle of optical activity, thereby establishing a direct linkage between structure and physical properties. it is also interesting to note that their proposals came without experimental verification and they were largely based on experiments conducted by others. philosophical arguments can, however, be invoked to satisfactorily validate this deductive reasoning.
2003	tami i. spector	the aesthetics of molecular representation: from the empirical to the constitutive∗	key words: aesthetic functionalism, affinity tables, alchemical distancing, atomic symbols, chemical nomenclature	abstract. this paper examines the negative response to dalton's atomic symbols by situating them in the context of the normative eighteenth-century representational system of affinity tables. aesthetic analysis of the affinity tables reveals them as schema embedded with a potent functionalist empiricism. in contrast, the aesthetics of dalton's symbols is associated with hypotheticodeductivism and alchemical iconicism.
2005	a.t. balaban	reflections about mathematical chemistry		abstract. a personal account is presented for the present status of mathematical chemistry, with emphasis on non-numerical applications. these use mainly graph-theoretical concepts. most computational chemical applications involve quantum chemistry and are therefore largely reducible to physics, while discrete mathematical applications often do not. a survey is provided for opinions and definitions of mathematical chemistry, and then for journals, books and book series, as well as symposia of mathematical chemistry.

1999	daniel rothbart	on the relationship between instrument and specimen in chemical research		abstract. based on the design of many modern chemical instruments, information about a specimen is retrieved after the specimen undergoes agitation, manipulation and disturbance of its internal state. but can we retain the traditional ideal that instruments should reveal properties that are definable independently of all modes of detection? in this paper i argue that the capacity of chemical instruments to convert experimental phenomena to information places constraints on the way in which the specimen is characterized. during research, the specimen is defined by those properties which permit its detection. based on modern instrumentation, this constraint necessitates a conception of the specimen as a reactive system of dynamical properties. the dream of a purely transparent detection process violates the design of chemical instruments. this mutual dependence of instrument and specimen is illustrated by empirical studies of the geometrical configuration of dna.
2000	davis baird	encapsulating knowledge: the direct reading spectrometer		abstract. the direct reading emission spectrometerwas developed during the 1940s. by substituting photo-multiplier tubes and electronics for photographic film spectrograms, the interpretation of special lines with a densitometer was avoided. instead, the instrument provided the desired information concerning percentage concentration of elements of interest directly on a dial. such instruments ‘de-skill’ the job of making such measurements. they do this by encapsulating in the instrument the skills previously employed by the analyst, by ‘skilling’ the instrument. this paper presents a history of the development of the dow chemical/baird associates direct reader. this history is used to argue for a materialist conception of knowledge. the instrument is a material form of knowledge, knowledge of aspects of spectroscopy, analytical spectrochemistry, electronics, instrument design and construction, and metal production industry economics.

2000	r. bruce king	the role of mathematics in the experimental/theoretical/computational trichotomy of chemistry		abstract. the drastically increasing availability of modern computers coupled with the equally drastically lower cost of a given amount of computer power in recent years has resulted in the evolution of the traditional experimental/ theoretical dichotomy in chemistry into an experimental/theoretical/computational trichotomy. this trichotomy can be schematically represented by a triangle (the etc triangle) with experimental, theoretical, and computational chemistry at the three vertices. the et and ec edges of the etc triangle depict the uses of theoretical and computational chemistry, respectively, to predict and interpret experimental results. the tc edge depicts the relationship between theoretical and computational chemistry. mathematics plays an increasing role in all aspects of chemistry, particularly theoretical chemistry, and has led to the evolution of the discipline of mathematical chemistry. research in mathematical chemistry can be considered to lie on a chemistry-mathematics continuum depending on the relative depths of the underlying chemistry and mathematics. examples of the author's own research lying near each end of the chemistry-mathematics continuum include his work on applications of graph theory and topology in inorganic coordination and cluster chemistry lying near the chemistry end and his work on chirality algebra lying near the mathematics end. the general points in this essay are illustrated by an analysis of the roles of computational and theoretical chemistry in developing an understanding of structure and bonding in deltahedral boranes and related carboranes. this work has allowed extension of the concept of aromaticity from two dimensions as in benzene and other planar hydrocarbons to the third dimension in deltahedral boranes.
2002	pier luigi luisi	emergence in chemistry: chemistry as the embodiment of emergence		abstract. the main aim of the paper is to reinforce the notion that emergence is a basic characteristic of the molecular sciences in general and chemistry in particular. although this point is well accepted, even in the primary reference on emergence, the keyword emergence is rarely utilized by chemists and molecular biologists and chemistry textbooks for undergraduates. the possible reasons for this situation are discussed. the paper first re-introduces the concept of emergence based on very simple geometrical forms; and considers some simple chemical examples among lowand high molecularweight compounds.on the basis of these chemical examples, a few interesting philosophical issues inherent to the field of emergence are discussed – again making the point that such examples, given their clarity and simplicity, permit one to better understand the complex philosophical issues. thus, the question of predictability is discussed, namely whether and to what extent can emergent properties be predicted on the basis of the component's properties; or the question of the explicability (a top down process). the relation between reductionism and emergentism is also discussed as well as the notion of downward causality and double causality (macrodeterminism); namely the question whether and to what extent the emergent properties of the higher hierarchic level affect the properties of the lower level components. finally, the question is analyzed, whether life can be considered as an emergent property. more generally, the final point is made, that the re-introduction of the notion of emergence in chemistry, and in particular in the teaching, may bring about a deeper understanding of the meaning of chemical complexity and may bring chemistry closer to the humanistic areas of philosophy and epistemology.

2004	joseph e. earley sr.	would introductory chemistry courses work better with a new philosophical basis? _	key words: chemical education, cosmology, dynamic systems, evolution, metaphor, process	abstract. one of the main functions that introductory chemistry courses have fulfilled during the past century has been to provide evidence for the general validity of 'the atomic hypothesis.' a second function has been to demonstrate that an analytical approach has wide applicability in rationalizing many kinds of phenomena. following r.g. collingwood, these two functions can be recognized as related to a philosophical 'cosmology' (worldview, *weltanshauung*) that became dominant in the late renaissance. recent developments in many areas of science, and in chemistry, have emphasized the central importance of understanding synthetic, developmental, and evolutionary aspects of nature. this paper argues that these scientific developments, and changes in other aspects of culture, amount to a widespread shift to an alternative cosmology, a quite different general worldview. to the extent that this is the case, introductory chemistry courses ought to be changed in fundamental ways. rather than having a main focus on analysis to microscopic components, introductory chemistry instruction should emphasize current scientific understanding of the (synthetic) evolutionary origins of the present world. this altered approach would provide good preparation for future professional work, while also making better contact with the perceived concerns of students.
2006	joseph e. earley, sr.	some philosophical influences on ilya prigogine's statistical mechanics		abstract. during a long and distinguished career, belgian physical chemist ilya prigogine (1917–2003) pursued a coherent research program in thermodynamics, statistical mechanics, and related scientific areas. the main goal of this effort was establishing the origin of thermodynamic irreversibility (the ''arrow of time'') as local (residing in the details of the interaction of interest), rather than as global (being solely a consequence of properties of the initial singularity – the ''big bang''). in many publications for general audiences, he stated the opinion that this scientific research had great philosophical importance. prigogine and his colleagues considered that the most recent stages of this research program have been successful, so that the local origins of the arrow of time are now established. there is no scientific consensus as to whether or not this claim is valid. similarly, there is no consensus on whether the competing global (initial singularity) explanation has been proven.
2006	ross. l. stein	a process theory of enzyme catalytic power – the interplay of science and metaphysics		abstract. enzymes are protein catalysts of extraordinary efficiency,capable of bringing about rate enhancements of their biochemical reactionsthat can approach factors of 1020. theories of enzyme catalysis, which seekto explain the means by which enzymes effect catalytic transformation of thesubstrate molecules on which they work, have evolved over the past centuryfrom the ''lock-and-key'' model proposed by emil fischer in 1894 to modelsthat explicitly rely on transition state theory to the most recent theories thatstrive to provide accounts that stress the essential role of protein dynamics.in this paper, i attempt to construct a metaphysical framework within whichthese new models of enzyme catalysis can be developed. this framework isconstructed from key doctrines of process thought, which gives ontologicpriority to becoming over being, as well as tenets of a process philosophy ofchemistry, which stresses environmentally responsive molecular transformation.enzyme catalysis can now be seen not as enzyme acting on itssubstrate, but rather as enzyme and substrate entering into a relation which allows them to traverse the reaction coordinate as an ontologic unity.

2002	jeffrey kovac	theoretical and practical reasoning in chemistry		abstract. traditional philosophy of science regards theoretical reasoning, based on the example of euclidian geometry, as the hallmark of a mature science. there is, however, a parallel tradition of practical reasoning based on specific cases that goes back to aristotle. in this paper i argue that practical reasoning is an essential part of the practice of chemistry and should be understood and appreciated on its own merits rather than regarded as a symbol of the immaturityand inferiority of chemistry as a science.
2005	m. kidwai and r. mohan m. kidwai and r. mohan	green chemistry: an innovative technology		abstract. the drive towards clean technology in the chemical industry with an increasing emphasis on the reduction of waste at source requires a level of innovation and new technology that the chemical industry is beginning to adopt. the green chemistry revolution provides an enormous number of opportunities to discover and apply new synthetic approaches using alternative feedstocks; ecofriendly reaction conditions, energy minimizations and the design of less toxic and inherently safer chemicals. in this review exciting opportunities and some successful examples of green chemistry in practice are described. while developments in the 20th century have brought various social and economic benefits to the people but these changes have also caused a range of environmental problems at both local and global levels. over recent years, sustainable development has been accepted by government, industry and the public as a necessary goal for achieving social, economic and environmental objectives (uark, 1999). within this, green chemistry (www.chemsoc.org/gen) plays a key role in maintaining and improving quality of our life and preserving natural environments. the term 'green chemistry' was first coined by the us environmental protection agency (epa) in the early 1990s and major interest in green chemistry in the us began in earnest with the passage of the 'pollution prevention act' of 1990. thus green chemistry becoming a formal focus of the epa in 1991.
2006	r. j. snooks	another scientific practice separating chemistry from physics: thought experiments		abstract. thought experiments in the history of science display a striking asymmetry between chemistry and physics, namely that chemistry seems to lack well-known examples, whereas physics presents many famous examples. this asymmetry, i argue, is not independent data concerning the chemistry/physics distinction. the laws of chemistry such as the periodic table are incurably special, in that they make testable predictions only for a very restricted range of physical conditions in the universe which are necessarily conditioned by the contingences of chemical investigation. the argument depends on how 'thought experiment' is construed. here, several recent accounts of thought experiments are surveyed to help formulate what i call 'crucial' thought experiments. these have a historical role in helping to judge between hypotheses in physics, but are not helpful in chemistry past or present.

1.6.4 Planilha revista Hyle

Ano	Pais	Autor/título	Título	Resumo
2004	Itália	Andrea Tontini. On the Limits of Chemical Knowledge	chemical language, structural formulas, chemical synthesis, limits of chemical knowledge, realism	Constraints on the representational capability of the language by which, in a simplistic yet truthful manner, chemists state knowledge of the spatial and electronic structure of molecules, are imposed by (a) the impossibility to prepare every conceivable compound bearing a specific structural fragment; and (b) objective limitations in our synthetic capabilities. Because intra- and intermolecular organization is depicted with a limited degree of detail, the prediction and explanation of chemical reactivity is hampered, and even more so our understanding of the molecular mechanisms underlying phenomena at higher levels of complexity. Epistemologically speaking, however, predictive failures are not entirely negative, as they often signal unprecedented chemical properties or events.
1999	Itália	Andrea Tontini. Developmental Aspects of Contemporary Chemistry Some Philosophical Reflections	development of contemporary chemistry, complexity and inexhaustibility of matter, novelty, by-products, molecular structure, realism	The development of contemporary chemistry is surveyed, in an attempt at grasping philosophical consequences: first, chemical research has revealed a potentially endless diversity of matter, and an abysmal complexity of its organization at the molecular level. Second, we may conjecture from reflections on some aspects of chemical reactivity that, owing to the limitations of human investigative means, reality is chemically unfathomable beyond a certain limit. In some instances, this may impede our understanding of the functioning of natural systems in terms of molecular-structural organization. Third, the overall consistency of results obtained by applying different analytical methods in order to establish molecular identity, along with the fact that we are able to interpret a great many different phenomena coherently in terms of molecular structure, indicates that matter – far from being something undifferentiated, easily moldable by the experiment, as anti-realistic views of science presuppose – really possesses a structure at the molecular level; a structure that can be reorganized only according to a formal disposition inherent to matter itself
2010	Colombia	Andrés Bernal and Edgar E. Daza On the Epistemological and Ontological Status of Chemical Relations	Chemical relations, external relations, internal relations, chemical atomism.	Following several authors, we point out the importance of relations in the conceptual frame of chemistry. We propose that an important characteristic of chemistry is given by the epistemological challenge associated with selectively related entities. We also suggest that internal relation ontologies have been seen by chemists as better suited for assessing this challenge, and that this ontological perspective has played an important role in shaping chemical concepts.
2006	Canada	Andrew Ede* Abraham Cressy Morrison in the Agora: Bringing Chemistry to the Public	images of chemists, popularization of chemistry, chemical industry, Abraham Cressy Morrison, Leon Söderston.	This paper looks at the visual and textual images of chemists in A. Cressy Morrison's Man in a Chemical World. It argues that Morrison was attempting to create a public image of an American chemist different from European chemists. Morrison and the illustrator Leon Söderston, working on behalf of the American Chemical Society, attempted to associate chemists and chemical industry with American prosperity by linking the 'man in the white lab coat' to religious and secular themes. This approach is analyzed using the concept of metonyms. Metonyms are a way of encapsulating complex ideas and associations within simple, often iconic, images in text and illustrations.

1999	Itália	Antonino Drago & Romina Oliva Atomism and the Reasoning by a Non-Classical Logic	atomism, logic, Avogadro	Often, in the original scientific writings, a double negated statement (DNS) is not equivalent to his corresponding positive one; that means the inferring law ¬¬A ® A does not apply. Recent studies recognized in the failure of this logical law the borderline between classical and non-classical logics. Original writings by classical chemists dealing with the problem of atomism are particularly characterized by the occurrences of DNSs. An historical case, Avogadro's contribution to atomism (i.e. the well-known hypothesis about the constitution of gases), is here analyzed in such terms. It turns out that, in order to support his ideas, Avogadro suggested several ad absurdum proofs, indeed a way of reasoning typically linked to the use of DNSs.
2003	França	Barbara Obrist. Visualization in Medieval Alchemy	visualization in alchemy, science and craft, transformation, analogy, metaphor.	This paper explores major trends in visualization of medieval theories of natural and artificial transformation of substances in relation to their philosophical and theological bases. The function of pictorial forms is analyzed in terms of the prevailing conceptions of science and methods of transmitting knowledge. The documents under examination date from the thirteenth to the fifteenth century. In these, pictorial representations include lists and tables, geometrical figures, depictions of furnaces and apparatus, and figurative elements mainly from the vegetable and animal realms. An effort is made to trace the earliest evidence of these differing pictorial types.
2004	França	Bernadette Bensaude-Vincent. Two Cultures of Nanotechnology ?	nanotechnology , self-assembly, molecular assembler, biomimetism, mechanism, dynamism.	Although many active scientists deplore the publicity about Drexler's futuristic scenario, I will argue that the controversies it has generated are very useful, at least in one respect. They help clarify the metaphysical assumptions underlying nanotechnologies, which may prove very helpful for understanding their public and cultural impact. Both Drexler and his opponents take inspiration from living systems, which they both describe as machines. However there is a striking contrast in their respective views of molecular machineries. This paper based on semipopular publications is an attempt to characterize the rival models of nanomachines and to disentangle the worldviews underpinning the uses of biological reference on both sides. Finally, in an effort to point out the historical roots of the contrast in the concepts of nanomachines, I raise the question of a divide between two cultures of nanotechnology.
2009	França	Bernadette Bensaude-Vincent* Boundary Issues in Bionanotechnology: Editorial Introduction		

2010	França	Bernadette Bensaude-Vincent* Biomimetic Chemistry and Synthetic Biology: A Two-way Traffic Across the Borders	synthetic biology, nature versus artifact, self-assembly, reductionism, vitalism.	Crossing the boundaries – between nature and artifact and between inanimate and living matter – is a major feature of the convergence between nanotechnology and biotechnology. This paper points to two symmetric ways of crossing the boundaries: chemists mimicking nature's structures and processes, and synthetic biologists mimicking synthetic chemists with biological materials. However to what extent are they symmetrical and do they converge toward a common view of life and machines? The question is addressed in a historical perspective. Both biomimetic chemistry and synthetic biology can be described as descendants of an ambitious program developed by Stéphane Leduc who coined the phrase 'synthetic biology' in the early twentieth century. The main intention of this genealogy is to emphasize that although making life in a test tube is a recurrent project there are subtle nuances in the underlying metaphysical assumptions. This comparison is meant to contribute to a better understanding of the cultural issues at stake in the convergence between nano and biotechnologies. It suggests that the demarcation line between life and inanimate matter remains a hot issue, and that all traffics across the borders do not proceed from the same metaphysical assumptions.
2001	USA	Brian P. Coppola* The Technology Transfer Dilemma:Preserving morally responsible education in a utilitarian entrepreneurial academic culture	technology transfer, entrepreneurial activity, ethics, graduate education.	Abstract: 'Research, teaching, and service' is growing to include business. With unbridled enthusiasm, academicians bring discoveries to market instead of having them sit fallow in the public domain. Dilemmas have emerged. Academic scientists underwrite their work with public funds and employ a utilitarian labor force, namely, students seeking an education. The benefits from a successful business are significantly higher than in academic ventures, so the temptation increases to abrogate professional responsibilities and loyalties in favor of personal gain. Safeguards are needed for the institution and its students while simultaneously permitting the development of scientifically, socially, and economically important discoveries.
2005	USA	Bruce V. Lewenstein. What Counts as a 'Social and Ethical Issue' in Nanotechnology?	nanotechnology, social issues, ethical issues, equity, justice, power.	Abstract: As 'social and ethical issues' becomes a recurring phrase in the community paying attention to nanotechnology research, a crucial question becomes: what counts as a social and ethical issue? A typical list includes privacy, environmental health and safety, media hype, and other apparently unrelated issues. This article surveys those issues and suggests that concerns about fundamental concepts of ethics, such as fairness, justice, equity, and especially power, unite the various issues identified as 'social and ethical issues' in nanotechnology.
2000	USA	Carl Trindle (Charlottesville/ VA, USA): "Entering Modeling Space. An Apprenticeship in Molecular Modeling" (pp. 145-160)	molecular modeling, molecular mechanics, electronic structure, computer graphics, chemical education	Twenty years ago computer modeling had made its first major impact on the chemist's patterns of thought. Now it is prominent in research and graduate education, and has made its presence felt throughout the undergraduate curriculum. I describe two consultations with chemists specializing in synthesis, by which I intend to illustrate (1) attitudes of novices to the craft; (2) experiences in apprenticeship which include flights of depression, disillusion, and elation; and (3) changes in their judgment of computer modeling as they make it part of their armory of concepts and images. The examples treat aspects of the chemical system not easily incorporated into structural formulas (chirality) and even physical models (relative energetics), but which are offered in computer modeling systems with molecular mechanics or quantum mechanical energy estimators. On the way, we can arrive at a notion of the changing value of computer modeling, and its impact on the chemist's frame of mind.

2010	França	Catherine Larrère* Ethics and Nanotechnology : The Issue of Perfectionism	nanotechnology , biotechnology, ethics, theology, perfectionism.	This paper aims at investigating perfectionism, as the project, shared by biotechnologies and nanotechnologies, of human enhancement. This project is commonly criticized (by Jean-Pierre Dupuy or Michael Sandel) as representing a kind of hyper-agency, a Promethean aspiration to remake nature, including human nature, to serve our purposes, and satisfy our desires. It should thus be addressed as a metaphysical or even theological problem. We would like to argue that this project is not so much Promethean as it is Pelagian. It does not aim so much at being as powerful as God, than at achieving individual, personal felicity, the way Pelagus argued that all men could achieve their own perfection. We argue that the claim of perfectionism is first an ethical one, since it pertains to what Sidgwick called 'egoist hedonism'. We then question this claim from a social point of view: What kind of social relationships is implied by the quest for individual perfectionism. This is an ethical as well as an epistemological question.
2005	USA	Christopher J. Preston. The Promise and Threat of Nanotechnology Can Environmental Ethics Guide US?	nanotechnology , environmental ethics, nature, fabricated biology, evolution.	The growing presence of the products of nanotechnology in the public domain raises a number of ethical questions. This paper considers whether existing environmental ethics can provide some guidance on these questions. After a brief discussion of the appropriateness of an environmental ethics framework for the task at hand, the paper identifies a representative environmental ethic and uses it to evaluate four salient issues that emerge from nanotechnology. The discussion is intended both to give an initial theoretical take on nanotechnology from the perspective of environmental ethics and to provide a clear indication of the direction from which environmental resistance might come.
2001	UK	Claus Jacob. Analysis and Synthesis Interdependent Operations in Chemical Language and Practice	chemical language, syntax, synthesis, analysis, combinatorial chemistry.	Chemical symbolism provides the linguistic representations for experimental research. It is based on an empirical set of formal (syntactic) rules that allows operations on formulas and reaction equations. The semantic interpretation of formulas and reaction equations links these operations to experimental analysis and synthesis. These syntactic and semantic aspects of chemical symbolism guide as well as limit chemical research. A better understanding of these aspects of chemical language allows chemists to rationalize novel approaches to chemical research (e.g. combinatorial chemistry) and possibly exploit the vast area of 'surprise discoveries'.
2005	Alemanha, UK	Claus Jacob & Adam Walters* Risk and Responsibility in Chemical Research: The Case of Agent Orange	Keywords: Ethics, risks, responsibility, Agent Orange.	Abstract: The synthesis of new chemical substances causes a number of ethical problems frequently overlooked by chemists, such as the risk associated with the creation of a new substance and the question of ultimate responsibility for a new compound. The case of the synthesis and subsequent use of Agent Orange can be used to exemplify these issues. Risk as well as responsibility for the agent have shifted significantly since its discovery, from the original inventor of a new compound, via the industrial manufacturer of a dioxin-contaminated herbicide, to the user of the impure agent as tactical chemical weapon in Vietnam. Analyzing the chain of historical events in the light of moral responsibility allows us to set everyday chemistry into an ethical context and ask a number of important questions, such as who carries responsibility for a new chemical compound, its safety and its proliferation.
2004	USA	Cyrus C.M. Mody. Small, but Determined: Technological Determinism in Nanoscience	Keywords: nanotechnology , non-presentism, futurism, social construction.	Analysis of technological determinism by historians, sociologists, and philosophers has declined in recent years. Yet understanding this topic is necessary, particularly in examining the dynamics of emerging technologies and their associated research areas. This is especially true of nanotechnology, which, because of its roots in futurist traditions, employs unusual variants on classical determinist arguments. In particular, nanotechnology orients much more strongly to the past and future than most traditional disciplines. This non-presentism strongly colors its proponents' articulation of the field's definition, purview, and likely development. This paper explores nano's non-presentism and suggests ways to further explore nano-determinism.

2007	Irlanda	D. Robert Lloyd* The Chemistry of Platonic Triangles: Problems in the Interpretation of the Timaeus	Plato's chemistry, elements, F. M. Cornford, group theory, Platonic solids.	Plato's geometrical theory of what we now call chemistry, set out in the Timaeus, uses triangles, his stoicheia, as the fundamental units with which he constructs his four elements. A paper claiming that these triangles can be divided indefinitely is criticized; the claim of an error here in the commentary by F.M. Cornford is unfounded. Plato's constructions of the elements are analyzed using simple point group theory. His procedure generates fully symmetric polyhedra, but Cornford's 'simpler' alternatives generate polyhedra with low symmetries and multiple isomeric forms. However, Cornford's principle of constructing larger triangles by assembling smaller ones is still valid.
2001	Alemanha	Daniel Haag*& Martin KaupenjohannBiogeochemical Models in the Environmental Sciences The Dynamical System Paradigm and the Role of Simulation Modeling	Keywords: models in biogeochemistry, dynamical system, simulation model, self-modifying system, complexity.	Dynamical systems are the paradigm for the representation of complex systems. The fixed encoding in a closed set of equations, however, contrasts with the openness of biogeochemical systems. Parameter identification is a major problem in biogeochemical systems and calibration of parameters converts models into 'fitting machines'. Openness, self-modification, and historicity of biogeochemical systems make non-trivial predictions of future outcomes impossible. Notwithstanding, simulation models serve as instruments of synthesis and have heuristic value to challenge existing data and theories. The modeling process itself, as a learning and communication process, can be a mode of coping with different types of complexity.
1997	USA	Daniel Rothbart, Irmgard Scherer(1997). Kant's Critique of Judgment and the Scientific Investigation of Matter	Kant, judgment, purposiveness, experimentation, investigation of matter	Kant's theory of judgment establishes the conceptual framework for understanding the subtle relationships between the experimental scientist, the modern instrument, and nature's atomic particles. The principle of purposiveness which governs judgment has also a role in implicitly guiding modern experimental science. In Part 1 we explore Kant's philosophy of science as he shows how knowledge of material nature and unobservable entities is possible. In Part 2 we examine the way in which Kant's treatment of judgment, with its operating principle of purposiveness, enters into his critical project and underlies the possibility of rational science. In Part 3 we show that the centrality given to judgment in Kant's conception of science provides philosophical insight into the investigation of atomic substances in modern chemistry.
2003	UK	David Knight. Exalting Understanding without Depressing Imagination' Depicting Chemical Process	visualization of chemical process, chemical manipulation, laboratory apparatus, textbook illustrations	Alchemists' illustrations indicated through symbols the processes being attempted; but with Lavoisier's Elements (1789), the place of imagination and symbolic language in chemistry was much reduced. He sought to make chemistry akin to algebra and its illustrations merely careful depictions of apparatus. Although younger contemporaries sought, and found in electrochemistry, a dynamical approach based upon forces rather than weights, they found this very difficult to picture. Nevertheless, by looking at chemical illustrations in the eighty years after Lavoisier's revolutionary book, we can learn about how reactions were carried out, and interpreted, and see that there was scope for aesthetic judgement and imagination.
2006	UK	David Knight** Popularizing Chemistry: Hands-on and Hands-off*		

2000	Alemanha	Eric Francoeur. Beyond dematerialization and inscription Does the materiality of molecular models really matter?	Keywords: molecular models, materiality, representation, stereochemistry, conformational analysis.	Taking a critical stance towards the notions of dematerialization and inscription, this paper considers the role of physical molecular models in chemical research, specifically in the development of structural concepts and in the articulation of chemists' knowledge of molecular structures. The main argument, illustrated through specific historical case studies, is that the materiality of these models, their specific properties as material objects, is not simply incidental to the role they have played in the development of chemistry.
2005	USA	Some Aspects of the Eric R. Scerri. Metaphysics of Chemistry and the Nature of the Elements	Metaphysics, element, periodic table, reference theory, Kripke & Putnam.	Abstract: There is now a considerable body of published work on the epistemology of modern chemistry, especially with regard to the nature of quantum chemistry. In addition, the question of the metaphysical underpinnings of chemistry has received a good deal of attention. The present article concentrates on metaphysical considerations including the question of whether elements and groups of elements are natural kinds. It is also argued that an appeal to the metaphysical nature of elements can help clarify the re-emerging controversies among chemists regarding the placement of the elements hydrogen and helium in the periodic system and the question of whether there exists a best form of the periodic table.
2007	USA	Eric R. Scerri* The Ambiguity of Reduction	quantum mechanics, quantum chemistry, epistemological reduction, ontological reduction, emergence, positivism.	I claim that the question of whether chemistry is reduced to quantum mechanics is more ambiguous and multi-faceted than generally supposed. For example, chemistry appears to be both reduced and not reduced at the same time depending on the perspective that one adopts. Similarly, I argue that some conceptual issues in quantum mechanics are ambiguous and can only be laid to rest by embracing paradox and ambiguity rather than regarding them as obstacles to be overcome. Recent work in the reduction of chemistry is also reviewed, including discussions of the ontological reduction of chemistry and the question of the emergence of chemistry from physics.
2006	Novazelandia	Ernst Homburg. From Chemistry for the People to the Wonders of Technology: The Popularization of Chemistry in the Netherlands during the Nineteenth Century	popularization of chemistry, popular chemistry books, Netherlands, 19th century, Gerrit Jan Mulder, Jan Willem Gunning.	This article analyzes phases in the production of popular Dutch chemistry books in terms of their audiences and the character of the texts. While the first popular chemistry books (1809-1815), which were directed to women, youngsters, and common people, contained moralistic and physico-theological contemplations, these were absent in books that between 1830 and 1844 diffused 'useful knowledge' among the working classes. The next period (1845-1864) was a hey-day, which also marked the end of the old style of popularization of chemistry. After 1865 the number of popular chemistry books dropped considerably, as a result of (a) the professionalization of chemistry; (b) the introduction of chemistry as a school subject; and (c) the separation between science and religion. Until 1900 chemical technology became almost the exclusive focus of popular chemistry texts.
1997	Itália	Giuseppe Del Re (1997). Technology and the spirit of alchemy	technology, alchemy, analogy, correspondence, ethics, spiritual standards	A historical perspective can throw light on problematic aspects of technology, regarded as part of the scientific approach to Nature. The master reference in this respect is chemistry, a science which still gives priority, as its mother alchemy, to the practical imitation and emulation of Nature's most secret operations. Now, the transition from the fogs of alchemy to the rigor of chemistry is often attributed to the abandonment of the religious foundations of the alchemical 'philosophy'. In this paper, we argue that, on the contrary, the complete elimination of the 'spirit of alchemy' was an unjustified loss and a premise for the misuses of technology now seriously dreaded.

1998	Itália	Giuseppe Del Re (1998). Ontological Status of Molecular Structure	ontology, molecular structure, quantum mechanics, analogy, observability	Molecular structure (MS) has been treated as a convention or an epiphenomenon by physicists and quantum chemists interpreting the mathematical formalism of quantum mechanics as the essential reality criterion in the submicroscopic world (R2 world). This paper argues that, (a) even in the R2 world there is a class of entities which are real per se, even though they cannot be separated from their material support, and MS may belong to that class; (b) MS actualizes a particular molecule from the many potentialities of a given set of nuclei and electrons, all present in the same Schrödinger equation; (c) MS is a fact established in the XIXth century, albeit as a result of circumstantial evidence (because of its belonging to the R2 world); (d) the fact that MS is known, as all objects of the atomic world, in terms of analogies with macroscopic models, is not valid grounds for questioning its reality; (e) MS is a set of topological as well as geometrical relations. All along the discussion, observability according to Bohr, Heisenberg, Feynman is taken as the essential criterion of reality in the R2 world. On its basis, quantum mechanics is by no means in conflict with the reality of molecular structure and shape. On the other hand, the question of the minimum lifetime required for a MS proper to exist should be left open, pending a detailed analysis of measurement techniques.
2000	Itália	Giuseppe Del Re Models and analogies in science	models, analogies, idealization, truth, molecular spring-and-ball models	Science makes extensive use of models, i.e. simplified or idealized representations of the systems found in the physical world. Models fall into at least two categories: mathematical and physical models. In this paper, we focus attention mainly on the latter, trying to show that they are essential tools not only of the scientific description of the world 'out there', but of man's cognition of things, especially things not directly accessible to the senses. The spring-and-ball (SB) model of chemistry is a most instructive example of a physical model. In other disciplines, from cosmology to physiology, models are used that are of the same kind or play the same role. It is concluded that physical models are objects which belong to the world accessible to man's direct experience, often constructed ad hoc and possibly idealized. They serve as referents for analogies, which appear to be indispensable in most aspects of scientific theorizing, especially for the understanding of the submicroscopic levels of reality
2001	Itália	Giuseppe Del Re. Ethics and Science	ethical values for science, choiceworthiness and research decisions, rules of conduct, risk of research choices, responsibility of researchers	Consideration of possible bearing of ethics on scientific activity as such – i.e. beside moral or legal conditions on applications of science and avoidance of frauds or superficiality – lead to the conclusion that scientists, particularly chemists, ought to ponder the choiceworthiness of every free action they undertake in the pursuit of scientific knowledge, for it may involve tampering with the harmonious evolution of nature and society, indeed with human beings themselves. It seems unavoidable that a decision should be based on the fundamental values of the tradition of mankind, expressed by the three Platonic values. Such a foundation, unfortunately, cannot show a way to eliminate all risks of wrong choices. Since, nevertheless, to contribute to the increase of knowledge is a professional and moral duty of a scientist; the latter is usually obliged to take a decision. He must be aware that his personal responsibility may be engaged.
2005	Alemanha	Gregor Schiemann. Nanotechnology and Nature On Two Criteria for Understanding Their Relationship	nanotechnology, concept of nature, laws of nature, life, artificial life	Abstract: Two criteria are proposed for characterizing the diverse and not yet perspicuous relations between nanotechnology and nature. They assume a concept of nature as that which is not made by human action. One of the criteria endorses a distinction between natural and artificial objects in nanotechnology; the other allows for a discussion of the potential nanotechnological modification of nature. Insofar as current trends may be taken as indicative of future development, nanotechnology might increasingly use the model of nature as a point of orientation, while many of its products will continue to be clearly distinguished from nature.

2010	UK	Hasok Chang* The Hidden History of Phlogiston How Philosophical Failure Can Generate Historiographical Refinement	Chemical Revolution, phlogiston, history and philosophy of science, scientific change, Lavoisier.	Historians often feel that standard philosophical doctrines about the nature and development of science are not adequate for representing the real history of science. However, when philosophers of science fail to make sense of certain historical events, it is also possible that there is something wrong with the standard historical descriptions of those events, precluding any sensible explanation. If so, philosophical failure can be useful as a guide for improving historiography, and this constitutes a significant mode of productive interaction between the history and the philosophy of science. I illustrate this methodological claim through the case of the Chemical Revolution. I argue that no standard philosophical theory of scientific method can explain why European chemists made a sudden and nearly unanimous switch of allegiance from the phlogiston theory to Lavoisier's theory. A careful re-examination of the history reveals that the shift was neither so quick nor so unanimous as imagined even by many historians. In closing I offer brief reflections on how best to explain the general drift toward Lavoisier's theory that did take place.
2004	Austrália	Heinz L. Kretzenbacher. The Aesthetics and Heuristics of Analogy Model and Metaphor in Chemical Communication	metaphor, aesthetics, semiotics, semasiotropy, creativity.	This paper suggests a sufficiently consistent, if preliminary, sketch of the semiotic structure and the aesthetic and heuristic functions of metaphor in science, particularly in chemistry. A propositional concept of metaphor, as underlying previous theories, is disputed. Metaphor is instead semiotically explained as a form of semiosis by way of semasiotropy – a concept developed out of Leopold Kretzenbacher's research in iconotropy. The function of scientific metaphor as an aesthetic agent of creative inference is discussed in terms of Harald Weinrich's image field theory (Bildfeldtheorie). In science, the increase in complexity through the heuristic process is subsequently reduced by strict selection of accepted research.
2002	USA	Henry H. Bauer. Pathological Science' is not Scientific Misconduct (nor is it pathological)	pathological science, scientific misconduct, cold fusion, polywater, N-rays.	Pathological' science implies scientific misconduct: it should not happen and the scientists concerned ought to know better. However, there are no clear and generally agreed definitions of pathological science or of scientific misconduct. The canonical exemplars of pathological science in chemistry (N-rays, polywater) as well as the recent case of cold fusion in electrochemistry involved research practices not clearly distinguishable from those in (revolutionary) science. The concept of 'pathological science' was put forth nearly half a century ago in a seminar and lacks justification in contemporary understanding of science studies (history, philosophy, and sociology of science). It is time to abandon the phrase.
2001	Belgica	Jaap van Brakel. Modeling in Chemical Engineering*	modeling, chemical engineering, similarity considerations, dimensional analysis, ceteris paribus conditions.	Models underlying the use of similarity considerations, dimensionless numbers, and dimensional analysis in chemical engineering are discussed. Special attention is given to the many levels at which models and ceteris paribus conditions play a role and to the modeling of initial and boundary conditions. It is shown that both the laws or dimensionless number correlations and the systems to which they apply are models. More generally, no matter which model or description one picks out, what is being modeled is itself a model of something else. Instead of saying that the artifact S models the given B, it is therefore better to say that S and B jointly make up B and S.
1999	Italia	Jacopo Tomasi (Pisa, Italy): "Towards 'chemical congruence' of the models in theoretical chemistry" (pp. 79-115)	models in theoretical chemistry, theoretical analysis, methodological criteria for models, chemical concepts	A series of 'growth crises' in the methodological framework of chemistry has led to serious discrepancies between the operational approach used in experimental practice and the methods and models used in theory. The theory, based on the quantum version of microphysics, has met difficulties in giving to its concepts an operational status congruent with that of experimental chemistry. The process of redefinition is examined here, on the basis of an analysis of theoretical chemical models and on criteria to judge their congruence with this process of methodological harmonization.

2003	USA	James Elkins. Four Ways of Measuring the Distance Between Alchemy and Contemporary Art	alchemy, aesthetics, modern art, postmodern art	Alchemy has always had its ferocious defenders, and a small minority of artists remain interested in alchemical meanings and substances. In this essay I will suggest two reasons why alchemy is marginal to current visual art, and two more reasons why alchemical thinking remains absolutely central. Briefly: alchemy is irrelevant because (1) it is has been a minority interest from early modernism to the present, and therefore (2) it is outside the principal conversations about modernism and postmodernism; but alchemy is central because (3) it provides the best language to explain the fascination of oil paint, and (4) it is one of the best models for understanding the contemporary aversion to full logical or rational sense.
2001	USA	Gifts and Commodities in Chemistry Jeffrey Kovac*	ethics, gift economy, intellectual property, patents, shared fate individualism.	Using the quadrant model for scientific research developed by Donald E. Stokes, and the ideas of the gift and commodity economies, I discuss some important ethical questions raised by the commodification of scientific research. Even in pure research, the possibility of patents and private ownership of information challenges the traditional professional values of science. When the research has applications, as much of chemistry does, the ethical challenges are even greater. Finally, I consider some broader policy issues and introduce the idea of shared fate individualism as a way to analyze the knotty questions that arise.
2007	Suécia	Jesper Sjöström* The Discourse of Chemistry (and Beyond)	discourse of chemistry, nature and culture of chemistry, objectivism, modernism, chemical Bildung.	This paper discusses the mainstream discourse of chemistry and suggests a complementary discourse. On a disciplinary level, the discourse of chemistry is based on objectivism, rationalism, and molecular reductionism. On a societal level, the discourse is based on modernism. The aims of chemical research and education are often unclear, which nowadays often leads to an emphasis on the needs from industry. Integrating meta-perspectives (philosophical, historical, and socio-cultural) within chemical research and education practice would – apart from providing chemical Bildung to practitioners – also improve the image of chemistry, and in the long run create a more reflective and problematizing discourse.
1997	alemanha	Joachim Schummer (1997). Challenging Standard Distinctions between Science and Technology: The Case of Preparative Chemistry	preparative chemistry, science and technology, poietical science, Aristotle.	Part I presents a quantitative-empirical outline of chemistry, esp. preparative chemistry, concerning its dominant role in today's science, its dynamics, and its methods and aims. Emphasis is laid on the poietical character of chemistry for which a methodological model is derived. Part II discusses standard distinction between science and technology, from Aristotle (whose theses are reconsidered in the light of modern sciences) to modern philosophy of technology. Against the background of results of Part I, it is argued that all these distinctions fail, because the underlying concepts of science are either out-dated, one-sided, or arbitrary. A deeper understanding of today's sciences requires, in particular, a philosopical investigation of chemistry.
1998	alemanha	Joachim Schummer (1998). The Chemical Core of Chemistry I: A Conceptual Approach*	chemical properties, logical structure of chemical knowledge, pure substances, chemical classification, theory of structural formulas	Given the rich diversity of research fields usually ascribed to chemistry in a broad sense, the present paper tries to dig our characteristic parts of chemistry that can be conceptually distinguished from interdisciplinary, applied, and specialized subfields of chemistry, and that may be called chemistry in a very narrow sense, or ‘the chemical core of chemistry’. Unlike historical, ontological, and ‘anti-reductive’ approaches, I use a conceptual approach together with some methodological implications that allow to develop step by step a kind of cognitive architecture for chemistry, which basically contains: (1) systematic chemical knowledge on the experimental level; (2) clarification of chemical species; (3) chemical classification systems; (4) theoretical foundation through the chemical theory of structural formulas. In a succeeding paper the results will be checked for resisting physicalistic reduction.

2001	Alemanha	Joachim Schummer Ethics of Chemical Synthesis	Keywords: ethics of synthetic chemistry, responsibility, utilitarian and nonutilitarian ends of synthesis, chemical weapons research, freedom of research.	Unlike other branches of science, the scientific products of synthetic chemistry are not only ideas but also new substances that change our material world, for the benefit or harm of living beings. This paper provides for the first time a systematical analysis of moral issues arising from chemical synthesis, based on concepts of responsibility and general morality. Topics include the questioning of moral neutrality of chemical synthesis as an end in itself, chemical weapons research, moral objections against improving material conditions of life by chemical means, and freedom of research. The paper aims at providing both a sound basis for moral judgements of chemistry in a public discourse and a framework for chemists to reflect on the moral relevance of their activity.
2003	Alemanha	Joachim Schummer. Aesthetics of Chemical Products Materials, Molecules, and Molecular Models	chemistry and art, aesthetic theories, molecules, materials, molecular models.	By comparing chemistry to art, chemists have recently made claims to the aesthetic value, even beauty, of some of their products. This paper takes these claims seriously and turns them into a systematic investigation of the aesthetics of chemical products. I distinguish three types of chemical products – materials, molecules, and molecular models – and use a wide variety of aesthetic theories suitable for an investigation of the corresponding sorts of objects. These include aesthetics of materials, idealistic aesthetics from Plato to Kant and Schopenhauer, psychological approaches of Ernst Gombrich and Rudolf Arnheim, and semiotic aesthetics of Nelson Goodman and Umberto Eco. Although the investigation does not support recent claims, I point out where aesthetics does and can play an import role in chemistry. Particularly, Eco's approach helps us understand that and how aesthetic experience can be a driving force in chemical research.
2007	Alemanha, USA	Joachim Schummer & Tami I. Spector* The Visual Image of Chemistry: Perspectives from the History of Art and Science	public image of chemistry, visual stereotypes, history of art, aesthetics, history of science.	In this paper we investigate the most important visual stereotypes of chemistry as they occur in current portraits of chemists, depictions of chemical plants, and images of chemical glassware and apparatus. By studying the historical origin and development of these stereotypes within the broader context of the history of art and science, and by applying aesthetic and cultural theories, we explore what these images implicitly communicate about the chemical profession to the public. We conclude that chemists, along with commercial artists, have unknowingly created a visual image of chemistry that frequently conveys negative historical associations, ranging from imposture to kitsch. Other elements of this image, however, aestheticize chemistry in a positive manner by referring to classical ideals of beauty and borrowing from revered motifs of modern art.
1998	USA	John Visintainer (1998). A Potential Infinity of Triangle Types On the Chemistry of Plato's Timaeus	ontology, Plato's chemistry, atomism, elements, perfect solids	Francis Cornford's assertion that there must be a smallest elemental triangle in the Platonic chemistry of the Timaeus is overturned in this paper. I show that, according to Plato, there need not be such a triangle and there might be a potentially infinite amount of elemental triangles. In doing so, I follow the interpretation of the Platonic chemistry first proposed by Bruins. Finally, I draw some conclusions with regard to Plato's relationship to atomism and modern chemistry.
2004	USA	José López. Bridging the Gaps: Science Fiction in Nanotechnology	nanoscience and technology, ethical and social implications, science fiction, extrapolation.	Abstract: This paper argues that narrative elements from the science fiction (SF) literary genre are used in the discourse of Nanoscience and Technology (NST) to bridge the gap between what is technically possible today and its inflated promises for the future. The argument is illustrated through a detailed discussion of two NST texts. The paper concludes by arguing that the use of SF narrative techniques poses serious problems to the development of a critical analysis of the ethical and social implications of NST.

1998	USA	Joseph E. Earley, Sr. Modes of Chemical Becoming	ontology, chemical entities, van der Waals complexes, chaos, coherence, oscillatory reactions.	In the characterization of the ArCl2 'van der Waals complex', a recognizable pattern of well-defined peaks is observed in the microwave absorption spectrum. In the control of chaos in a chemical oscillatory reaction the power spectrum progressively becomes simpler, at length yielding a single peak. Since both of these cases generate coherences that are centers of agency, they should be considered to produce new chemical entities. Applicability of this ontological approach to coherences of wider societal interest is suggested.
2008	USA	Joseph E. Earley, Sr.* How Philosophy of Mind Needs Philosophy of Chemistry	Keywords: physicalism, philosophy of chemistry, philosophy of mind, mereology, structuralism, emergence, downward causation.	By the 1960s many, perhaps most, philosophers had adopted 'physicalism' – the view that physical causes fully account for mental activities. However, controversy persists about what counts as 'physical causes'. 'Reductive' physicalists recognize only microphysical (elementary-particle-level) causality. Many, perhaps most, physicalists are 'non-reductive' – they hold that entities considered by other 'special' sciences have causal powers. Philosophy of chemistry can help resolve main issues in philosophy of mind in three ways: developing an extended mereology applicable to chemical combination; testing whether 'singularities' prevent reduction of chemistry to microphysics; and demonstrating 'downward causation' in complex networks of chemical reactions.
2002	USA	Kathrine Krageskov Eriksen. The Future of Tertiary Chemical Education – A Bildung Focus?	Keywords: ethics, tertiary chemical education, Bildung, risk society, reflectivity.	Abstract: In this study the concept of Bildung as an aim for tertiary chemical education is discussed, particularly seen in the light of the challenges of society as they can be identified in Ulrich Beck's perspective on the emerging society as a 'risk society'. The importance of reflectivity as part of contemporary Bildung is highlighted, and the role of ethics in this reflectivity is specifically discussed.
1997	alemanha	Klaus Mainzer (1997). Symmetry and Complexity-Fundamental Concepts of Research in Chemistry	molecular structure, symmetry, symmetry breaking, complexity, nonlinearity	Molecules have more or less symmetric and complex structures which can be defined in the mathematical framework of topology, group theory, dynamical systems theory, and quantum mechanics. But symmetry and complexity are by no means only theoretical concepts of research. Modern computer aided visualizations show real forms of matter which nevertheless depend on the technical standards of observation, computation, and representation. Furthermore, symmetry and complexity are fundamental interdisciplinary concepts of research inspiring the natural sciences since the antiquity.
2000	Alemanha	Klaus Mainzer (Augsburg, Germany): "Computational Models and Virtual Reality. New Perspectives of Research in Chemistry" (pp.135-144)	computational model, computer network, visualization, virtual reality	Molecular models are typical topics of chemical research depending on the technical standards of observation, computation, and representation. Mathematically, molecular structures have been represented by means of graph theory, topology, differential equations, and numerical procedures. With the increasing capabilities of computer networks, computational models and computer-assisted visualization become an essential part of chemical research. Object-oriented programming languages create a virtual reality of chemical structures opening new avenues of exploration and collaboration in chemistry. From an epistemic point of view, virtual reality is a new computer-assisted tool of human imagination and recognition.

2005	França	Louis Laurent & Jean-Claude Petit. Nanosciences and its Convergence with other Technologies New Golden Age or Apocalypse?	nanosciences, nanotechnologies, fears, sociology of science and technology, controversies.	Abstract: Nanosciences and nanotechnologies are developing at an incredibly rapid pace, promising a true revolution in a wide variety of fields where the capability to manipulate matter at the atomic or (supra)molecular scale is essential. This includes information processing systems, medical diagnoses and treatments, energy production and sustainable development, as well as a number of more futurist ideas that, as yet, remain pure fiction. These developments have begun to generate controversies and fears in the scientific community itself and the larger public. This article critically reviews the potential problems of an uncontrolled 'nanoworld' (grey goo, toxicity of nanoparticles, RFIDs, privacy, etc.) and the associated fears, as they appear in the literature. Suggestions to effectively manage controversies in this field, based on a sociological approach, are proposed.
1998	Itália	Luigi Cerruti. Chemicals as Instruments A Language Game	chemicals, instruments, language game, epistemology of solvents, physical phenomena, chemical substances	Meaning is use: Wittgenstein's well-known dictum is used as starting point for a language game on the English word 'instrument' in historical discourse. In this way it is possible to collect a set of words (and corresponding objects) so heterogeneous that the likening 'chemicals as instruments' does not seem misplaced. Looking for a better understanding, three classes of chemicals are considered: solvents, indicators, and reagents (just a couple!). The first two classes comprise chemicals, which create new experimental conditions (as the classical air pump), or measure 'something' (as the classical thermometer). The third class is more peculiar to chemistry, in that reagents are typical chemical instruments for operating at the microscopic level. In addition, a second language-game is proposed, and it is stressed the deep epistemological difference between physics, which creates 'phenomena', and chemistry, which synthesizes substances.
1999	Itália	Luigi Cerruti. Historical and Philosophical Remarks on Ziegler-Natta Catalysts A Discourse on Industrial Catalysis	Ziegler-Natta catalysts, industrial catalysis, chemical discourse	Part 1 outlines the complex, parallel historical evolution of Ziegler-Natta catalysts and related problems. In Part 2, as a general method of inquiry, chemical language and discourse are analyzed, at first to clarify chemists' epistemic views and the ontological status of catalysts. After analyzing contrasting definitions of 'catalyst' and the chemical properties of catalysts, a suitable metaphor is suggested for catalytic activity, and then 'applied' to different cases of industrial catalysis (incl. Ziegler-Natta). The last two sections deal with intellectual attitudes to industrial catalysis and the makeup of industrial catalysis as academic discipline. In conclusion, I suggest that references to the economic level of reality (the industrial production) serve both a better understanding of the microscopic level of reality (the chemical process), and a higher status at the social level of reality (the chemical community).
2010	Poland	Łukasz Lamża* How Much History Can Chemistry Take?	Astrochemistry, geochemistry, classification of chemical compounds, nomothetic and idiographic sciences, unification of science	Chemistry is typically considered to be a nomothetic science, i.e. a science interested in general laws rather than historical facts. Also, the unification of science is usually envisioned as an effort to connect particular scientific disciplines through their laws, e.g., the laws of chemistry are to be derived from the laws of physics. It is however equally sensible to combine the sciences through a single cosmic history. There is a large literature following this direction, albeit rarely focused on chemistry. In this paper some ideas concerning the possible role of a 'historical' (or 'idiographic') chemistry are presented, with special attention to the notion of a 'genetic' classification of chemical compounds, and to the counterintuitive proposition that many major branches of physics may in fact be explained by chemistry, not the opposite.

2006	USA	Marcel C. LaFollette. Taking Science to the Marketplace Examples of Science Service's Presentation of Chemistry during the 1930s	popularization of chemistry, 20th century, Science Service.	During the 1930s, Science Service, a not-for-profit independent news organization, promulgated an approach to popularizing science which favored audience preferences over scientific agendas and attended to industry as well as academic research interests. Stories about chemistry and chemists harmonized well with Science Service's emphasis on research utility and relevance. This article describes examples from syndicated news reports, radio broadcasts, a newspaper series called 'Fabrics of the Future', and a department store exhibit on chemistry that traveled through the United States in 1939-40.
2007	França	Marika Blondel-Mégrelis* Liebig or How to Popularize Chemistry	: popularization of chemistry, image of chemistry, 19th century, Justus Liebig.	The popularization of chemistry was one of Liebig's major tasks. I examine why one of the most famous theoreticians and experimenters of organic chemistry came to this new and rather unusual project in the mid-19th century, and how he managed to create a new image of chemistry: no longer the servant of pharmacists and physicians, it must be considered the most useful of all sciences and the most popular..
2004	UK , Filand	Nanotechnology : Generalizations in an Interdisciplinary Field of Science and Technology Martin Meyer & Osmo Kuusi*	nanotechnology , technology generalizations, leitbild systems, foresight, Delphi.	This paper reports on work-in-progress in the area of technology generalization. More specifically, it presents a model that allows integrating various expectations regarding emerging technologies. Nanotechnology is used as an example of a novel field of science and technology. The notion of leitbild ('guiding image') is used as a mediating concept pointing to potentially emerging technologies. Then we discuss to what extent patent and publication data can facilitate identifying scientific and technological trends and how to evaluate the epistemic utility of a leitbild.
2008	USA	Mi Gyung Kim* The 'Instrumental' Reality of Phlogiston	eighteenth-century chemistry, Sulphur Principle, Fire, Phlogiston, affinity table	The stability of phlogiston in eighteenth-century French chemistry depended not on its role as a comprehensive theory, but on its operational (instrumental), theoretical, and philosophical (speculative) identities that were forged in different contexts, yet were interwoven to designate a single substance. It was as 'real' as any other chemical substance to the degree that it was obtained through material operations, occupied a place in the theoretical edifice of the affinity table, and was endowed with a corpuscular ontology. Lavoisier labeled it as an 'imaginary' substance because it offered a unique resistance to his vision of the new chemistry based on 'metric' measurements and algebraic representations.
1997	UK	F. Michael Akeroyd - Conceptual Aspects of Theory Appraisal: Some Biochemical Examples	amino-acids, chemi-osmotic, consiliense, problem solving, teleology, chemical education, biochemical education.	This paper considers papers on conceptual analysis by Laudan (1981) and Whitt (1989) and relates them to three biochemical episodes: (1) the modern 'biochemical explanation' of acupuncture; (2) the chemio-osmotic hypothesis of oxidative phosphorylation; (3) the theory of the complete digestion of proteins in the gut. The advantages of including philosophical debate in chemical/biochemical undergraduate courses is then discussed.

2002	UK	F. Michael Akeroyd* Why was a Fuzzy Model so Successful in Physical Organic Chemistry?	Keywords: fuzzy logic, fuzzy model, possibilistic reasoning, physical organic chemistry, reaction mechanism.	Abstract: This paper examines a facet of the rise of the Hughes-Ingold Theory of Nucleophilic Substitution in Organic Chemistry 1933-1942, arguing that the SN1/SN2 model of reaction mechanism used by Hughes and Ingold is an example of a fuzzy model. Many real world 'Fuzzy Logic' Controlling Devices gave better results compared to classical logic controlling devices in the period 1975-1985. I propose that the adoption of fuzzy principles in the Hughes-Ingold program 1933-1940 led to scientific advance at a time when the rival programs, based on classical principles, had stalled owing to problems associated with the fuzziness of the data. I suggest also that there is an analogy between the success of second generation fuzzy logic controllers 1985-95 and the success of the successor Winstein model from 1956 onwards.
2002	USA	Michael Davis. Do the Professional Ethics of Chemists and Engineers Differ?*	profession, ethics, morality, code of conduct, chemists, engineers.	This paper provides a sketch of my general way of understanding professions and then applies that sketch to a specific question, how to distinguish between two very similar professions, chemistry and engineering. I argue that the professional ethics of chemists do differ from the professional ethics of engineers and that the differences are important. The argument requires definition of both 'ethics' and 'profession' – as well delving into the details of chemistry and engineering.
2009	França	Michel Morange* A Critical Perspective on Synthetic Biology	synthetic biology, engineering, modularity, evolution, modeling	Synthetic biology emerged around 2000 as a new biological discipline. It shares with systems biology the same modular vision of organisms, but is more concerned with applications than with a better understanding of the functioning of organisms. A herald of this new discipline is Craig Venter who aims to create an artificial microorganism with the minimal genome compatible with life and to implement into it different 'functional modules' to generate new micro-organisms adapted to specific tasks. Synthetic biology is based on the possibilities raised by genetic engineering, but it aims to engineer organisms, and not simply to modify them, mimicking the practice of computer engineers. Three points will be discussed: In what regard does synthetic biology represent a new epistemology of the life sciences? What are the relations between synthetic biology and evolutionary biology? What is the raison d'être of synthetic biology as a discipline independent of nanotechnologies?
2001	Alemanha	Things, stuffs, and coincidence A non-ontological point of view Nikos Psarros*	stuffs, substances, coinciding objects, abstraction, predication.	In this article the problem of the so-called 'coinciding objects', i.e. the question whether a substantially homogeneous thing is something ontologically different from the corresponding 'piece of stuff' it is made of or not, is examined from a pragmatical and language-analytical point of view. Instead of recurring to ontological assertions, I propose to regard 'stuffs' or 'substances' as a mode of speaking about things that fulfil the condition of being homogeneous in respect to a certain kind of properties that are called substantial properties. The coincidence problem is resolved by demonstrating that terms for substantially homogeneous things and the corresponding 'pieces of stuff' are predicative expressions in an Aristotelian genus-species relationship.
2004	USA	Otávio Bueno. The Drexler-Smalley Debate on Nanotechnology: Incommensurability at Work?	Keywords: nanotechnology, Drexler-Smalley debate, molecular assemblers, incommensurability	In a recent debate, Eric Drexler and Richard Smalley have discussed the chemical and physical possibility of constructing molecular assemblers – devices that guide chemical reactions by placing, with atomic precision, reactive molecules. Drexler insisted on the mechanical feasibility of such assemblers, whereas Smalley resisted the idea that such devices could be chemically constructed, because we do not have the required control. Underlying the debate, there are differences regarding the appropriate goals, methods, and theories of nanotechnology, and the appropriate way of conceptualizing molecular assemblers. Not surprisingly, incommensurability emerges. In this paper, I assess the main features of the debate, the levels of the emerging incommensurability, and indicate one way in which the debate could be decided.

2000	Poland	Pawel Zeidler The Epistemological Status of Theoretical Models of Molecular Structure	rigid and dynamic model of molecular structure, representation, quantum theory of molecular structure, local interpretation with procedural character	For many decades, chemists regarded rigid models of molecular structure as representing structures of real molecules as their attributes. However, new experimental data required a new theoretical conceptualization. The rigid model has been replaced with a dynamic model in which molecular structure is changed under the influence of environmental conditions. The above case shows some problems connected with recognizing theoretical models as structural representations of real empirical systems. Owing to the fact that theoretical models of molecular structure obtain local interpretations with a procedural character, they can be carriers of specific information about structures of real molecules. Finally, I argue that, although theoretical models can be well corroborated empirically, they cannot be treated as representations of real empirical systems but can play a very important role in experimental practice.
2000	Alemanha	Peter J. Ramberg. Pragmatism, Belief, and Reduction tereoformulas and Atomic Models in Early Stereochemistry	atomic models in 19th century chemistry, stereochemistry, affinity, pragmatism, reduction	In this paper I explore the character and role of stereoformulas and models of the atom that appeared in the early history of stereochemistry, including those of Jacobus Henricus van't Hoff, Aemilius Wunderlich, Johannes Wislicenus, Victor Meyer, Arthur Hantzsch, Alfred Werner, and Hermann Sachse. I argue that stereochemists constructed and used stereoformulas in a pragmatic way that ignored the physical implications of the spatial distribution of valence, and that the models of the atom were created to reconcile the physically curious concept of valence with known physical laws. Although such models were explanatory at a deeper level, they had little impact on the theory and practice of chemistry, and were not serious attempts to reduce chemical theory to physical laws.
2006	UK	Peter Morris* The Image of Chemistry Presented by the Science Museum, London in the Twentieth Century: An International Perspective	presentation of chemistry in museums, chemistry collections, chemistry galleries, Science Museum, Deutsches Museum.	How has chemistry been presented at the Science Museum, London, during the 20th century? After an overview of the history of the Science Museum and its chemistry galleries, four galleries are considered in depth (1906, 1926, 1977, and 1999). The importance of the curators' external constituency of chemists and chemical educators is emphasized. The image of chemistry at the Science Museum has concentrated on the general utility of chemistry and chemistry as a skilful craft. The presentation has been low-key rather than boosterist. A comparison is made with the chemistry galleries at the Deutsches Museum. Chemistry in the Deutsches Museum has put more emphasis on hands-on exhibits and the chemical industry. Science and technology museums have promoted chemistry in a quiet but successful way for many years, but their influence may have waned along with chemistry kits.
2006	Alemanha	Peter Weingart. Chemists and their Craft in Fiction Film	Keywords: public perception of science, chemistry in movies, alchemy, mad scientist.	The paper presents results from a quantitative analysis of some 200 fiction films. Chemistry is the iconic discipline of the 'mad scientist' reflecting the alchemical imagery that was prevalent until recently (and can still be identified) in the depiction of science in films. Other results show the ambivalence with which primarily the natural sciences are represented in popular movies.

2006	UK	Philip Ball. Chemistry and Power in Recent American Fiction	chemistry in literature, chemistry in society, science and art, fiction.	Writers of fiction have always held up a mirror to the world around them. The perspective they typically present is not one gathered from polls of public opinion, nor is it culled from the way issues are presented in the media. Yet in retrospect, the personal attitudes and views expressed in good literary fiction frequently prove to offer a revealing snapshot of trends in thought and topics of debate in the writer's milieu. With this in mind, I shall explore some of the themes on chemistry and society developed in the fictional works of three modern American writers. I believe that these examples provide food for thought, and possibly a little encouragement, to those who despair at the tarnished image that chemistry commonly seems to have in broader public discourse today. For while all of the texts I consider examine some of the fears often expressed about the chemical industry, they show a willingness to engage with issues of risk (real and perceived), social benefits, changing patterns of consumer behavior, and responsibility that is not always present in more conventional modes of ecocriticism.
2000	Franaça	Pierre Laszlo. Playing with Molecular Models	molecular models, play, transitional object, toys, tinkering	Any serious study of the uses of molecular models in chemistry has to mention play as an essential component. A research chemist will use them not unlike a young child playing with a toy: exploring their features, trying out their resilience, probing their innards, tinkering, day-dreaming, and thus finding out new avenues of adventures of the mind and in the laboratory. Reasons for such an assimilation of a molecular model to a toy are given and assessed critically.
2001	França	Pierre Laszlo . Handling Proliferation	ethics, activism, alchemy, discovery, know-how, plagiarism	The ethics of the chemist identify with those of the citizen, in principle. The observed perversions, such as proliferation of chemicals, stem from the values of a chemical community closed upon itself, and from the attendant identification of a mere know-how with a science. The epistemic degradation produces moral indifference.
2003	França	Pierre Laszlo. Foundations of Chemical Aesthetics	artificial, invisible, natural, unexpected, wonder	In these prolegomena to a chemical aesthetics, eleven separate theses are asserted: (1) the natural is more beautiful; (2) the artificial is more beautiful; (3) the invisible is yet more beautiful than the visible; (4) the need for visualization is unavoidable; the beauty of chemistry stems from (5) an inner logic and (6) its unpredictability; (7) any change is handsome on account of its invariant elements; (8) the beauty in any change is the fleeting instant; the beauty of chemistry is that it is (9) a science of the complex and (10) a science of the simple; (11) a new contemporary art has been born.
2006	França	Pierre Laszlo. On the Self-Image of Chemists, 1950-2000	Keywords: self-image of chemists, 20th century, chemophobia, instrumental revolution, biological turn	Abstract: The field of chemistry is highly diverse. Yet, the aggregate picture of chemists, according to this study, shows them to constitute a highly homogeneous and even gregarious group, in terms of their self-image. They see themselves as creative, as benefactors of humankind, and as craftsmen upholding a tradition of intelligent hands and preserving, even in the time of Big Science, a relatively low-tech profile. The stereotypical public image as the sorcerer's apprentices who befoul the environment and who manufacture chemical weapons is way off target. Chemists find it a caricature, it only reinforces the good conscience within the chemical community. Other conservative forces are the common language of structural formulas, a widespread phobia about mathematics, and the very length of the apprenticeship to be served. Conversely, between the mid-twentieth century and the advent of the twenty-first century, chemists displayed an impressive adaptability in the face of swift changes, regarding the tools of the trade – which the NMR Revolution had contributed to upgrade –, the funding of their activity at a much higher level, the oil crises, and the Biological Turn that affected them during that period.

1997	Franaça	Pierre Lazlo. Chemical Analysis as Dematerializatio n	chemical analysis, radical, formula, spectroscopy, synthesis	Chemical analysis is envisaged as an exemplar of laboratory work. Matter, held at a distance within the probe of instruments, is converted there into electronic signals. Matter serves only as prime material for information production. Chemical analysis converts instrumentalized readings into informational statements. Major chemical thinkers (Auguste Laurent, Justus von Liebig, Jean-Baptiste Dumas, and others) made this conceptual revolution. In mid-nineteenth century, they built a daring theory of radicals. Since that time, molecular chemistry became a combinatorial art and science of radicals. These, groups of atoms with only at first fictional existence, are analogous to phonemes in speech production.
2009	França	Raphaël Larrère* Questioning the Nano-Bio-Info-Convergence	convergence, molecular biology, computer science, reductionism, bottom-up	This paper proceeds from the hypothesis that two kinds of convergence can be distinguished: a theoretical convergence, when several scientific fields relate to the same model; and an instrumental convergence, when a scientific discipline provides other disciplines with scientific tools which are necessary to develop experiences. We will thus investigate the convergence between molecular biology and information science to discover that, in the 1960s, the convergence was theoretical, since molecular biology and genetics were built upon a metaphor drawn from computer science. Instrumental convergence was not reached until the development of microelectronics and microcomputers and the apparition of technologies specifically adjusted for biological (and medical) research. The current situation is characterized by the following paradox: biology, while becoming more and more performing, thanks to labs on chips, tends to free itself from the metaphor from which it originated and by which it was inspired for a long time.
2003	USA	Roald Hoffmann Thoughts on Aesthetics and Visualization in Chemistry		
2003	USA	Robert Root-Bernstein. Sensual Chemistry Aesthetics as a motivation for Research	aesthetics, art, discovery, intuition, thinking.	Sensual, aesthetic, and even artistic considerations are an important motivation for general interest in chemistry and the development of specific research problems. Examples are given showing how these considerations have been put into play by many eminent physical, theoretical, and synthetic chemists. It is argued that more attention needs to be given to sensual and aesthetic issues in understanding how chemical discoveries are made and in order to better teach the subject.
2000	UK	Robin F. Hendry (Durham, UK): "Molecular Models and the Question of Physicalism" (pp. 117-134)	chemistry, physicalism, reductionism, supervenience, disunity of science	By their own account, physicalists are committed to the claim that physics is causally complete, or closed. The claim is presented as an empirical one. However, detailed and explicit empirical arguments for the claim are rare. I argue that molecular models are a key source of evidence but that, on closer inspection, they do not support the completeness claim.
2006	Austrália	Roslynn Haynes. The Alchemist in Fiction: The Master Narrative	alchemists in fiction, Frankenstein, Faust, characters, narratives.	In Western culture, as expressed in fiction and film, the master narrative concerning science and the pursuit of knowledge perpetuates the archetype of the alchemist/scientist as sinister, dangerous, and possibly mad. Like all myths this story may appear simplistic but its recurrence suggests that it embodies complex ideas and suppressed desires and fears that each generation must work through. This paper explores some of the most influential examples of such characterization, links them to contemporary correlatives of the basic promises of alchemy and suggests reasons for the continuing power of such images.

2004	USA	Ross L. Stein* Towards a Process Philosophy of Chemistry	process philosophy, metaphysics, ontology, enzymes, evolution.	Molecular change is central to chemistry and has traditionally been interpreted within a metaphysical framework that places emphasis on things and substance. This paper seeks an alternative view based on process metaphysics. The core doctrines of process thought, which give ontological priority to becoming over being, cohere well with modern chemical thinking and support a view of molecules as dynamic systems whose identities endure through time as patterns of stability. Molecular change is then seen as excursions to new stability patterns. Finally, when molecular change is viewed as foundational to emergent complexity, process metaphysics allows evolution to be seen as creative molecular advance.
2010	França	Sacha Loeve* About a Definition of Nano: How to Articulate Nano and Technology?	nanotechnology , epistemology, science versus technology, molecular machine, individuation.	: It is often assumed that 'nano' is merely a communication and marketing token. Our inquiry in a number of French laboratories in the field of artificial molecular machines resulted in a quite different picture: a number of researchers are concerned with the definition of nanotechnology. This paper starts from the attempts made by one of the leading figure in the field of molecular machines, Christian Joachim, to draw a clear demarcation between what is 'really nano' and what is not. Probing the epistemological basis of his strategy, we also underline its limits. As this definition is only focused on the prefix 'nano', it would benefit from being completed and enlarged by a definition of 'technology'. We argue that molecular machines belong to the realm of technology in Gilbert Simondon's meaning of this term: a genesis of individualized objects coordinating natural processes and human projects. Finally, this emphasis on the technological dimension of nanotechnology leads to ethical reflections based on the practices of nanotechnology rather than on their potential applications.
2002	USA	Stefan Böschen. DDT and the Dynamics of Risk Knowledge Production	Keywords: sociology of risk research, case study on DDT, research programs.	Until today, the sociological analysis of risky technologies has moved between the two poles of risk constructivism and risk objectivism. A historical analysis of the evolution of risk knowledge may help clarify the issue. I argue that risk hypotheses can acquire the status of a fact in the course of risk debates. In this way, they are equipped with a certain 'robustness' and become guidance for action. As a case in point, I analyse the evolution of risk knowledge resources in the debate on DDT.
1997	USA	Stephen J. Weininger Contemplating The Finger: Visuality and the Semiotics of Chemistry	fictional science, maps, metaphors, representation, semiology, tables.	A historical overview of the development of chemical signs reveals the central role of the Table as a representational device, as well as its limitations. Furthermore, the decreasing importance of linguistic signs such as names, compared to iconic signs such as structural formulas, accords with and reinforces the intensely visual character of chemistry. Chemistry's symbolic language is shown to mimic many features of natural languages, including the ability to construct fictional worlds. I argue that these 'scientific fictions' are as cognitively valuable in chemistry as they are in ordinary life, and that chemists creatively mix 'true' and 'fictional' representations of molecules and substances.
2001	UK	Sylvia Nagl Neural network models of protein domain evolution	models in biochemistry, protein domain evolution, neural networks, ethics of modeling.	Protein domains are complex adaptive systems, and here a novel procedure is presented that models the evolution of new functional sites within stable domain folds using neural networks. Neural networks, which were originally developed in cognitive science for the modeling of brain functions, can provide a fruitful methodology for the study of complex systems in general. Ethical implications of developing complex systems models of biomolecules are discussed, with particular reference to molecular medicine.
2003	USA	Tami I. Spector. The Molecular Aesthetics of Disease The Relationship of AIDS to the Scientific Imagination	HIV protease, aesthetic functionalism, elegance, beauty, sublime.	This paper shows how the simulated molecular forms of HIV protease allow scientists to immerse themselves in the study of AIDS while simultaneously serving their aesthetic needs. To unravel the aesthetic nature of the computationally rendered representation of HIV protease, an analysis of the aesthetic function and properties of molecules is undertaken, with particular emphasis on the properties of tension, elegance, and sublimity.

2001	Alemanha	Ulrich Ruschig* Logic and chemistry in Hegel's philosophy	Hegel, logical development, measure, chemical concepts, logic and its material.	Hegel's chef-d'œuvre, the Science of Logic, contains a section on 'measure'. As 'measure' unites the two categories 'quality' and 'quantity', it is a key aspect for determining qualitative and quantitative objects, and hence is the decisive category for natural sciences. In the chemical passages of this section, Hegel took concepts from chemistry (for example 'elective attraction'), changed their function, and converted them into categories of logic. In this paper, the relationship between the development of categories by reflecting reason and the chemical material cited for this development is discussed. Hegel claimed that the chemical material presupposed in the logical development could be replaced with specified proportions of measures, derived from developing and specifying the category 'measure'. This claim is criticized.
2005	Russia	Valentin N. Ostrovsky* Towards a Philosophy of Approximations in the 'Exact' Sciences	Approximations in quantum chemistry, complementarity, shape of molecules, orbitals, Born-Oppenheimer approximation, Periodic Table.	The issue of approximations is mostly neglected in the philosophy of science, and sometimes misinterpreted. The paper demonstrates that approximations are in fact in the core of some recent discussions in the philosophy of chemistry: on the shape of molecules, the Born-Oppenheimer approximation, the role of orbitals, and the physical explanation of the Periodic Table of Elements. The ontological and epistemological significance of approximations in the exact sciences is analyzed. The crucial role of approximations in generating qualitative images and comprehensible models is emphasized. A complementarity relation between numerically 'exact' theories and explanatory approximate approaches is claimed.
2010	França	Vanessa Nurock* Nanoethics: Ethics For, From, or With Nanotechnologies?	nanoethics, moral cognition, applied ethics.	The concern for ethics is a leitmotiv when dealing with nanotechnologies. However, the target of this concern is far from being obvious, and the word 'nanoethics' itself has no clear-cut definition. Indeed, nanoethics is usually said to be 'the ethics of nanotechnologies', but it is never specified whether this 'ethics of nanotechnologies' is 'an ethics for nanotechnologies' or 'an ethics from nanotechnologies'. This paper aims to show that these two characterizations of nanoethics (for/from) imply different problems, but that they are both insufficient, even if necessary, to build a definition of nanoethics. In conclusion, I stress the idea that neither a 'top down' nor a 'bottom up' nanoethics are sufficient to characterize the ethics of nanotechnologies and that a 'reflexive equilibrium' is necessary in order to understand nanoethics as an ethics with nanotechnologies.
1998	Czech Republic	Vladimír Karpenko.(1998). Alchemy as donum dei	alchemy, religion, transmutation, donum dei, crafts	The view of alchemy as a gift of God is traced from her origin in the Hellenistic world through the Arabic world to Latin Europe. In the course of this history the attitude towards divine intervention changed; Hermes, the legendary (semidivine) founder of this science was not yet expected to intervene into the work of an alchemist. Already in the Hellenistic world alchemy became donum dei; the role of God graduated in the later cultures, and persisted surprisingly long in Latin Europe. Here, God was the decisive force presenting only selected people with his gift, the knowledge of alchemy. Crafts based on chemistry and metallurgy developed simultaneously in the same social and religious environment, but they took quite a different position - free access for people to learn all knowledge. Therefore, alchemy and crafts are to be compared also from the point of view of donum dei.

2009	França	Xavier Guchet* Nature and Artifact in Nanotechnologies	artifact, metaphysics, nature, operation, technology.	This paper discusses the common view that nanotechnology blurs the boundary between nature and artifact. At first glance, this claim seems to be justified by the 'artificial molecular machines' which play a central role in the development of nanotechnology. However in considering a few examples of design of artificial molecular machines, I first argue that the dual trend of artificialization of nature and naturalization of artifacts is not consistent. This antinomy is based on a tacit and never-questioned metaphysical assumption: nature and artifacts cannot be ontologically balanced. Their opposition relies on other conceptual divides between structure and operation, between being and becoming in classical metaphysics. I try to demonstrate that nanotechnology undermines this traditional metaphysical view. Nature cannot be described as a separate and permanent entity. It is more adequately characterized as a set of processes homogeneous with technological processes. Thus, far from erasing nature, nanotechnology conveys an operational view of nature that precisely belongs to a Techno-logy.

1.6.4 Autor, Ano, endereço, departamento

Ano	Pais	Autor	Endereço	Departamento
2003	França	Barbara Obrist	University of Paris VII	CNRS, UMR 7062
2005	UK	Adam Walters	University of Exeter	Adam Walters: School of Biological and Chemical Sciences
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2006	Canada	Andrew Ede	University of Alberta, Canada;	Department of History
1999	Itália	Antonino Drago	University of Naples	Group of History of Physics, Dept. of Physical Sciences
2001	USA	Brian P. Coppola	University of Michigan	Department of Chemistry
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2000	USA	Carl Trindle	University of Virginia	Dept. of Chemistry,
2010	França	Catherine Larrère	Université de Paris 1	UFR de philosophie, ,France
2005	USA	Christopher J. Preston	University of Montana,	Department of Philosophy
2004	USA	Cyrus C.M. Mody	Chemical Heritage Foundation	Chemical Heritage Foundation
2007	Irlanda	D. Robert Lloyd	Trinity College,	Chemistry Department,
2001	Alemanha	Daniel Haag	University of Hohenheim	Institute of Soil Science and Land Evaluation, Department of Soil Chemistry,
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2002	USA	Henry H. Bauer	Highland Circle	
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2001	Belgica	Jaap van Brakel	University of Leuven	Institute of Philosophy,
1999	Italia	Jacopo Tomasi	University	Dipartimento di Chimica e Chimica Industriale,
2003	USA	James Elkins	Instituto - School of the Art Institute	Department of Art History, Theory, and Criticism,
2001	USA	Jeffrey Kovac	University of Tennessee	Department of Chemistry,
2007	Suécia	Jesper Sjöström	Malmö University	School of Teacher Education, Department of Science, Environment and Society
1998	USA	John Visintainer	University (Marquette University)	
2004	USA	José López	University of Ottawa	Department of Sociology,
2002	Dinamarca	Kathrine Krageskov Eriksen	University of Copenhagen	Center for Science Education Studies,
2005	França	Louis Laurent & Jean-Claude Petit	DSM/DRECAM, CEA	Commissariat à l'Energie Atomique,
2010	Poland	Łukasz Lamża	University (The Pontifical University of John Paul II)	Department of Philosophy, Chair of Philosophy of Nature

2006	USA	Marcel C. LaFollette		
2007	França	Marika Blondel-Mégrelis	CNRS,	Institut d'Histoire et de Philosophie des Sciences et des Techniques
	alemanha	Martin Kaupenjohann	University of Hohenheim	Institute of Soil Science and Land Evaluation, Department of Soil Chemistry
2004	UK	Martin Meyer &	University of Sussex	Freeman Centre
2008	USA	Mi Gyung Kim	University (North Carolina State University)	Department of History,
2002	USA	Michael Davis	Instituto - Illinois Institute of Technology, Chicago	Center for the Study of Ethics in the Professions,
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2001	Aleman	Nikos Psarros	University of Leipzig, Leipzig	Institute of Philosophy
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2004	USA	Otávio Bueno	University of South Carolina	Department of Philosophy
2000	Poland	Pawel Zeidler	University (Adam Mickiewicz University	Department of Philosophy,
2000	Alemanha	Peter J. Ramberg	Max-Planck-Institut für Wissenschaftsgeschichte, Wilhelmstraße	The Science Museum
2006	UK	Peter Morris	Museu - The Science Museum	
2006	Alemanha	Peter Weingart	University of Bielefeld	Department of Sociology, Institute of Science and Technology Studies
2006	UK	Philip Ball	Nature	
2009	França	Raphaël Larrère	INRA – Unité de Recherche	Transformations Sociales et politiques liées au Vivant
2003	USA	Roald Hoffmann	University - Cornell University, Baker Laboratory	Department of Chemistry and Chemical Biology
2003	USA	Robert Root-Bernstein	University - Michigan State University	Department of Physiology
2000	UK	Robin F. Hendry	University of Durham	Department of Philosophy
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2004	USA	Ross L. Stein	University - Harvard Center for Neurodegeneration and Repair, Cambridge	Laboratory for Drug Discovery in Neurodegeneration,
2010	França	Sacha Loeve	University of Paris 10,	Department of Philosophy
2002	USA	Stefan Böschen	University of Augsburg	Institute of Sociology,
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2001	UK	Sylvia Nagl Neural	University College London	Department of Biochemistry and Molecular Biology,
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1998	Czech Republic	Vladimír Karpenko	University - Charles University	Department of Physical and Macromolecular Chemistry, Faculty of Sciences
2009	França	Xavier Guchet	Université Paris I	
2004	Itália	Andrea tontini	Università degli Studi di Urbino	Istituto di Chimica Farmaceutica e tossicologia
1999	itália	Andrea tontini	Università degli Studi di Urbino	Istituto di Chimica Farmaceutica e tossicologia

2005	Alemanha, UK	Claus Jacob	Universität des Saarlandes	School of Pharmacy,
2001	UK	Claus Jacob	University of Exeter,	School of Chemistry
2003	UK	David Knight	University of Durham	Department of Philosophy
2006	UK	David Knight	University of Durham	Department of Philosophy
2005	USA	Eric R. Scerr	University – UCLA	Department of Chemistry & Biochemistry,
2007	USA	Eric R. Scerr	University – UCLA	Department of Chemistry & Biochemistry,
1998	USA	Joseph E. Earley	University (Georgetown University	Department of Chemistry
2008	USA	Joseph E. Earley, Sr	University (Georgetown University	Department of Chemistry
2000	Alemanha	Klaus Mainzer	Institut für Interdisziplinäre Informatik	Lehrstuhl für Philosophie und Wissenschaftstheorie
1997	alemanha	Klaus Mainzer	Universität	Lehrstuhl für Philosophie und Wissenschaftstheorie
1998	Itália	Luigi Cerruti	Università di Torino	Dipartimento di Chimica Generale ed Organica Applicata
1999	itália	Luigi Cerruti	Università di Torino	Dipartimento di Chimica Generale ed Organica Applicata
1997	UK	Michael Akeroyd	Bradford College	Bradford College
2002	UK	Michael Akeroyd	Bradford College,	Bradford College
2003	USA	Tami I. Spector	University of San Francisco	Department of Chemistry,
2007	USA	Tami I. Spector	University of San Francisco,	Department of Chemistry,
2004	França	Bernadette bensaude-Vicent	Université Paris X, Fance;	Département de philosophie
2009	França	Bernadette bensaude-Vicent	Université Paris X, Fance;	Département de philosophie
2010	França	Bernadette bensaude-Vicent	Université Paris X, Fance;	Département de philosophie
1997	itália	Giuseppe del re	Università di Napoli "Federico II"	attedra di Chimica teorica,
2000	Itália	Giuseppe del re	Università di Napoli "Federico II"	attedra di Chimica teorica,
2001	Itália	Giuseppe del re	Università di Napoli "Federico II"	attedra di Chimica teorica,
1998	Itália	Giuseppe del re	Università di Napoli "Federico II",	Cattedra di Chimica teorica
2007	Alemanha,	Joachim Schummer	University of Darmstadt	Department of Philosophy
1998	alemanha	Joachim Schummer	University of Karlsruhe	Institute of Philosophy
2003	Alemanha	Joachim Schummer	University of Karlsruhe	Department of Philosophy
2001	Alemanha	Joachim Schummer	University of Karlsruhe,	Institute of Philosophy
1997	alemanha	Joachim Schummer	University of Karlsruhe	Institute of Philosophy,
2000	Franaç	Pierre Laszlo	Université de Liège	Institut de chimie
2001	França	Pierre Laszlo	École polytechnique,	Département de chimie
2003	França	Pierre Laszlo	École polytechnique,	Département de chimie
2006	França	Pierre Laszlo	École polytechnique,	Département de chimie
1997	Franaça	Pierre Lazlo	École polytechnique,	Département de chimie

1.6.5 Produção dos filósofos da química

1.6.5.1 Produção de Eric Scerri

Eric Scerri				
in press	to Italian edition of Linus Pauling's, The Nature of the Chemical Bond Preface			
2006	The Tyranny of the Chemist	Chemistry International		
2003	Film review of "What the bleep do we know?", Critical Inquirer, Sept			
2000	Waxing Philosophical About Chemistry, Chemistry, Published by American Chemical Society, co-authored with L. Guterman, 17-20, Winter 2000.			
1993	configurational Energy and Bond Polarity Index, , 97, 5786,.	Journal of Physical Chemistry		
1989	Eastern Mysticism and the Alleged Parallels with Physics, 57, no. 8, 687-692,.	American Journal of Physics,		
1989	Vychodní Mysticismus A Udajné Paralely s Fyzikou, Universum (Prague) 13, 3-13. 1994, Czech Translation of above paper from American Journal of Physics.			
1986.	The Tao of Chemistry, , 63, no. 2, 106-107,	Journal of Chemical Education		
1979	Low Frequency Raman Spectra of Polyoxymethylene, 20, no. 12,1470,.	, Polymer		
1980.	The Physical Significance of the Planck Length, Indian Journal of Theoretical Physics, 28, 389-91,			
1978.	The Mass-Space-Time Continuum, , 1, 3, 289,	Speculations in Science and Technology		
2005	Normative and Descriptive Philosophy of Science and the Role of Chemistry, in Philosophy of Chemistry		Conhecimento quimico	Normatividade e descritividade da quimica
2005	. Response to Barnes' Critique of Scerri and Worrall	Studies in History and Philosophy of Science	Debate	
2006	Commentary on Allen & Knight's Response to the Löwdin Challenge	., Foundations of Chemistry	Debate	
2002	Response to Katz, The Chemical Educator, E. Letter to the Editor (August 30, 2002). [Online], http://chemed.boisestate.edu.	Chem. Educator	Debate	
2000	Response to Nesbet, , 2, 77-78,	Foundations of Chemistry	Debate	
200	Second Response to Needham, , 14, 307-315,	International Studies in Philosophy of Science	Debate	
1999	Response to Needham, ,13, 185-1	International	Debate	

		Studies in Philosophy of Science		
2010.	Response to Taber on Chemical Constructivism, New Zealand	Journal of Chemical Education	Debate construtivismo	
2006.	On the Continuity of Reference of the Elements, A Response to Hendry	Studies in History and Philosophy of Science	Debate elemento	Debate com Hendry
in press	Top Down Causation from the Chemistry - , Interface Focus	Physics Perspective	Down causation	
2001	The New Philosophy of Chemistry and Its Application to Chemical Education, , 2, 165-170, 2001.	Cerapie	Educação quimcia	Aplicações a educação
2003	68. Philosophical Confusion in Chemical Education, , 468-474, 2003.	Journal of Chemical Education	Educação quimica	Confusão filosófica na educação quimica
2002	The Nature of Chemical Knowledge and Chemical Education, co-authored with rduran, in Chemical Education: Towards Research-Based Practice, J. Gilbert, O. De Jong, R. Justi, D.F. Teagust, J.H. Van Driel, (eds.), Kluwer, Dordrecht, 2002, p. 7-27.		Educação quimica	Natureza do conhecimento quimico
2000	Philosophy of Chemistry - A New Interdisciplinary Field?, , 77, 522-526, 2000.	Journal of Chemical Education	Educação quimica	Implicações da filosofia da quimica
1999	On the Nature of Chemistry, , (Mexico), 10, 74-78, 1999.	Educacion Química	Educação quimica	Natureza da quimica
2009	The Dual Sense of the Term "Element, Attempts to Derive the Madelung Rule and the Optimal Form of the Periodic Table, if any	., International Journal of Quantum Chemistry	elemento	Dual senso do conceito de element
1989.	Transition Metal Configurations and Limitations of the Orbital Approximation, 66, no. 6, 481-483,	, Journal of Chemical Education	Especifico	
1995	The Exclusion Principle, Chemistry and Hidden Variables, , 102,65-169,.	Synthese	Específico	
1994.	Prediction of the Nature of Hafnium from Chemistry, Bohr's Theory and Quantum Theory, , 51, 137-150,	Annals of Science	Especifo	
1997	Bibliography on Philosophy of Chemistry, , 111, 305-324, 1997.	Synthese	Filosofia da quimica	Bibliografia
1995	Philosophy of Chemistry Resurgens, , Beckman Center for History of Chemistry, Philadelphia, 13, no. 1, 33, Winter 1995-96.	Chemical Heritage	Filosofia da quimica	Introdução
1997	The Case for Philosophy of Chemistry, (co-authored with L. McIntyre), , 111, 213-232, 1997.	Synthese	negligenciamento	Redução, superveniencia
2005	Some aspects of the metaphysics of chemistry and the nature of the elements	., HYLE	ontologia	Natureza dos elementos quimicos
2000	Interdisciplinary Research at the Caltech Beckman Institute, in Practicing Interdisciplinarity, P. Weingart, N. Stehr (eds.), University of Toronto Press, 2000, pp. 194-214.		Outros	
1997	Interdisciplinary Research at the Beckman	Interdisciplinary	Outros	

	Institutes, , 22, 1-7, 1997.	Science Reviews		
1997	Chemical Periodicity, in Macmillan Encyclopedia of Chemistry, J.J. Lagowski ed., Macmillan, New York, vol. 3, 22-32, 1997.		Periodicidade	
1997	Are Chemistry and Philosophy Miscible?, 3, 44-46, 1997.	Chemical Intelligencer	Quimica e filosofia	
2000	Have Orbitals Really Been Observed?, 77, 1492-1494, 2000.	Journal of Chemical Education	Realiosmo	Observações de orbitais
2000	Naive Realism, Reduction and the 'Intermediate Position, in "Of Minds and Molecules",Bhushan, N., Rosenfeld, S., (eds.), Oxford University Press, New York, 2000.		Realism	Posição intermediária da quimica, entre realism naïve e reduciosnimo
2007	Reduction and Emergence in Chemistry Proceedings of the PSA 2006 Meeting, Philosophy of Science		Redução	Redução e emergencia em quimica
1993	The Reduction of Chemistry, Popper and Induction, in The Philosophy of Chemistry, Report of a meeting held at Science Museum, London, October, , London, 1993.	Royal Society of Chemistry	Redução	
2004	. Principles and Parameters in Chemistry and Physics		reducionismo	Teorias parametrizadas em quimcia
2003	How Ab Initio is Ab Initio Quantum Chemistry?, 6, 93	Foundations of Chemistry	reducionismo	Mencanica quantica explica via ab initio
2004	How Ab Inito is Ab Initio Quantum Chemistry ?, , Special Issue dedicated to Stuart Rosenfeld, N. Bhushan (guest editor), 6, 93-116, 2004.]	Foundations of Chemistry	reducionismo	Explicação pela mecanica quantica
2003	60. Löwdin's Remarks on the Aufbau Principle and a Philosopher's View of Ab Initio Quantum Chemistry, in Fundamental Perspectives in Quantum Chemistry, A Tribute Volume to the Memory of Per-Olov Löwdin, E. Brandas and E. Kryachko (eds.), Kluwer Academic Publishers, Dordrecht, Holland, 2003, 675-694.		reducionismo	Metodo ab initio
2002	Principles and Parameters in Chemistry and Physics, PSA 2002, 1082-1094, Philosophy of Science, (Supplement), Symposia Papers edited by S. Mitchell.		reducionismo	Teorias em quimica
2007	The Ambiguity of Reduction, - International Journal for Philosophy of Chemistry, 13, 67-81, 2007.	HYLE	Reducionismo	Ambiguidades da redução
2001	The Recently Claimed Observation of Atomic Orbitals and Some Related Philosophical Issues", , 68 (Proceedings) S76-S88, N. Koertge, ed. Philosophy of Science Association, East Lansing, MI, 2001	Philosophy of Science	reducionismo	Observações de orbitais atomicos
2000	The Failure of Reduction and How to Resist the Disunity of Science in Chemical Education, , 9, 405-425, 2000.	Science and Education	reducionismo	Fragmentação
1998	Popper's Naturalized Approach to the Reduction of Chemistry, , 12, 33-44,	International Studies in	reducionismo	Aproximação naturalizada

	1998.	Philosophy of Science		
1994	It All Depends What You Mean By Reduction, in From Simplicity to Complexity, Information, Interaction, Emergence, Proceedings of the 1994 ZiF Meeting in Bielefeld, 77-93, K. Mainzer, A. Müller, and W. Saltzer, eds., Vieweg-Verlag.		reducionismo	
1996	Reduktion und Erklärung in der Chemie, Philosophie der Chemie Bestandsaufnahme und Ausblik, K. Ruthenberg and N. Psarros, J. Schummer, eds. Würtzburg, Köningshausen & Neumann, 1996.		reducionismo	
1996	Why the 4s Orbital Is Occupied before the 3d", , 73, 6, 498-503, 1996. (Co-authored with M. Melrose).	Journal of Chemical Education	Reducionismo	
1994	Has Chemistry Been at Least Approximately Reduced to Quantum Mechanics? in PSA 1 D. Hull, M. Forbes, and R. Burian, eds., 160-170,		Reducionismo	
1993	Is Chemistry a Reduced Science?, 30, no. 4, 112,.	Education in Chemistry	Reducionismo	
1993	Correspondence and Reduction in Chemistry, in Correspondence, Invariance and Heuristics. Essays in Honour of Heinz Post, S. French and H. Kamminga, eds., Boston Studies in Philosophy of Science, no. 148: 45-64, Dordrecht: Kluwer,		Reducionismo	
1991	Electronic Configurations, Quantum Mechanics and Reduction, , 42, no. 3, 309-325,.	British Journal for the Philosophy of Science	Reducionismo	
1991	Chemistry, Spectroscopy and the Question of Reduction, , 68, no. 2, 122-126.	Journal of Chemical Education	Reducionismo	
2005	Introduction chapter, co-authored with D. Baird, L. McIntyre, in Philosophy of Chemistry, The Synthesis of a New Discipline, Baird, D., Scerri, E.R., McIntyre, L., (eds.), Boston Studies in the Philosophy of Science, Springer, Dordrecht, 2005, p. 3-18.		Sintese	Sintese da filosofia da quimica
2003	Philosophy of Chemistry, , May-June, 2003, 6-8	Chemistry International	Sintese	Sintese da filosofia da quimica
1999	La Filosofia de la Quimica, la Seccion Mas Reciente de la Filosofia de la Ciencia, Anuario Latino Americano de Quimica (), XI, 187-191, 1998-99.	Argentinean Journal of Chemical Education	Sintese	Introdução a filosofia da quimica
2011	Philosophy of chemistry: Where has it been and where is it going, including some comments on the Forum: The Philosophy of Classification, Knowledge Organization, 38, 9-24analytical approach, in Llored ed		Sintese da filosofia da química	Filosofia da classicação
1999	A Critique of Atkins' Periodic Kingdom and Some Writings on Electronic Structure", 1, 287-296, 1999.	Foundations of Chemistry	Tabela periodica	erros em livros didáticas do atkins

In press	. What is an element? What is the periodic table? And what does quantum mechanics contribute to the question, , in press	Foundations of Chemistry	Tabela periódica	Conceito de elemento e de tabela periódica Contribuições da mecânica quantica
In press	How should the periodic system be regarded? A brief look at some published proposals, Rutherford Magazine, in press		Tabela periódica	Tabela periódica por rutheford
in press	Trouble at Both Ends of the Periodic Table,	Education in Chemistry	Tabela periódica	
2011.	A review of research on the history and philosophy of the periodic table	Journal of Science Education	Tabela periódica	Revisão sobre história e filosofia da tabela periódica
2010	Discovering Rhenium, , 2, 598-598,	Nature Chemistry	Tabela periódica	Descoberta renio
2010	Explaining the Periodic Table and the Role of Chemical Triads	., Foundations of Chemistry	Tabela periódica	O papel das traides
2009	. Chemistry Goes Abstract: Finding francium	Nature Chemistry	Tabela periódica	
in press	Entry for "Periodic Table", in Elsevier Handbook of Philosophy of Science, R. Hendry, A. Woody, (eds.), Elsevier		Tabela periódica	Entrada na encyclopedia elsevier
2009	Tales of technetium	Nature Chemistry	Tabela periódica	
2009	Periodic Change	Chemistry World	Tabela periódica	
2008	Mendeleev's Periodic Table - Origins and Debate in Philosophical Themes in Chemistry, K. Jensen, A. Nielsen, Copenhagen		Tabela periódica	Questões filosóficas em Mendeleev
2008	86. Periodic Visions, Cosmos Magazine (Australia), 80, 72-77,.		Tabela periódica	
2008	The Past and Future of the Periodic Table,	American Scientist	Tabela periódica	Historic
2008	The Role of Triads in the Evolution of the Periodic System	Journal of Chemical Education	Tabela periódica	O papel das triádes
2007	Mendeleev's Legacy: The Periodic System	Chemical Heritage	Tabela periódica	O legado de mendellev
2006	. The Legacy of Mendeleev and his Periodic Table	Maltese Journal of Science	Tabela periódica	O legado de mendellev
2005	Presenting the left-step periodic table	., Education in Chemistry	Tabela periódica	
2006	. The Formalization of the Periodic System Revisited72, in Cognitive Structures in Scientific Enquiry, Essays in Debate with Theo Kuipers, Volume 2, Roberto Festa, Atocha Aliseda, and Jeanne Peijnenburg, eds., Poznan Studies in the Philosophy of the Sciences and the Humanities, Rodopi, Amsterdam, 2006tabela pe		Tabela periódica	Questões da formação da tabela periódica
2004	. Relative Virtues of the Pyramidal and Left-Step Periodic Tables, in The Periodic Table: Into the 21st Century		Tabela periódica	Virtudes da tabela pyramidal
2003	The Placement of Hydrogen in Periodic System, reprinted in Chemistry in Australia, 71, (4), 22		Tabela periódica	O lugar do hidrogenio

2003	The Placement of Hydrogen in Periodic System, , 26, (3), 21	Chemistry International	Tabela periódica	O lugar do hidrogenio
2005	The Formalization of the Periodic System Revisited, in Cognitive Structures in Scientific Inquiry, Volume dedicated to Theo Kuipers, R. Festa, (ed.), Poznan, Poland, 2005, 191-219.	Poznan Studies in Philosophy of Science,	Tabela periódica	Formalização revisitada
2001	Bibliography of Literature on the Periodic System, 3, 183-196, 2001. Co-author, J. Edwards.	, Foundations of Chemistry	Tabela periódica	Bibliografia
2001	A Philosophical Commentary on Giunta's Critique of Newlands' Periodic System, , 26, 124-132, 2001.	Bulletin for the History of Chemistry	Tabela periódica	Comentário ao sistema de newlands
2001	The Periodic Table: The Ultimate Paper Tool in Chemistry, in Tools and Modes of Representation in the Laboratory Sciences, Ursula Klein (ed.), Boston Studies in the Philosophy of Science, vol 222, KluwerAcademic Press, Dordrecht, 2001, pp.163-177.		Tabela periódica	Ferramenta principal da quimica
2001	Prediction and the Periodic Table, co-authored with J. Worrall, Studies in History and Philosophy of Science, 32, 407-452, 2001		Tabela periódica	Predição
1998	The Evolution of the Periodic System, Scientific American, September, 279, 78-83, 1998, translated into French, Italian, German, Spanish, Polish, Russian, Chinese, Japanese, Arabic.	Tabela periódica	Tabela periódica	Historic
1998	Ordinal Explanation of the Periodic System of Chemical ElementsE. R. Scerri, V. Kreinovich, P. Wojciechowski and R. R. Yager,International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, 6, 387-400, 1998.		Tabela periódica	Explicação ordinal
1998	How Good is the Quantum Mechanical Explanation of the Periodic Table?, 75, 1384-1385,1998.	Journal of Chemical Education	Tabela periódica	Expicação quantica da tabela periódica
1997	Has the Periodic Table Been Successfully Axiomatized?, 47, 229-243, 1997.	Erkentnnis	Tabela periódica	Axiomatização
1997	The Periodic Table and the Electron, American Scientist, 85, 546-553, 1997.		Tabela periódica	
1997	The Periodic System, Encarta Internet Encyclopedia, Microsoft Corporation.		Tabela periódica	
1996	Stephen Brush, The Periodic Table and the Nature of Chemistry,in Die Sprache der Chemie, P. Jannich and N. Psarros, eds. Proceedings of the Second Erlenmeyer Colloquium on Philosophy of Chemistry, Würtzburg, Köningshausen & Neumann, 1996, pp. 169-176.		Tabela periódica	Natureza da quimica
1994	Plus ça Change (The Periodic Table), , 30, no. 5, 379- 381,.	Chemistry in Britain	Tabela periódica	
2011	Who is a Theorist, , 8, No 3: 8(3)	Revista Eureka sobre Enseñanza y Divulgación de las Ciencias	Teoria	

1.6.5.2 Produção de Joachim Scummer

Área do conhecimento	Objeto central do trabalho	Ano
Conhecimento químico	Estudos cientometricos: objetivos, métodos da pesquisa em química	1997
	Essencia da quimica	1998
	Avaliação do impacto do crescimeto do conhecimento químico na educação documentação e trabalho do químico	1999
	Objetivos de fazer experimentos	2004
	Estudos cientométricos: o crescimento exponencial	1997
	Objetivo de fazer experimentos em química	1994
Epistemologia química	Propriedades materiais	1998
	O lugar da fisico química	1998
Estética da quimica	A importancia das imagens e da semiotica na nanotecnologia	2006
	Modelos, e moléculas	2003
Ética	Fundamentalismo técnico da nanotecnologia	2006
	Etica na nanotecnologia	2007
	Nanotecnologia	2008
	Etica na nanotecnologia	2008
	Ética na sínteses quimica	2001
	Implicações éticas na nanotecnologia	2005
	Justice moral na pesquisa em química	2005
	Tecnologia e ética	2009
	Interesses e grupos na dinamica social da nanotecnologia	2006
Explicação quimica	Reducionismo e explicação quimica e biológica	2003
Geral	Importância ecológica de uma filosofia da quimcia	1996
	Ciência, técnica e química	2001
	Relação com a natureza na descoberta dos medicamentos modernos	2004
	Noção de natureza em Quimica	2008
	Conhecimento quimico	2008
Imagem da ciencia	Imagem da ciencia em pictogramas	2008
Instrumentação na química	Representações visuais da ciencia	2007
	O impacto da instrumentação na especiação química	2002
	Interesse publico na nanotecnologia	
Metafisica da quimica	Relações quimica natureza na historiografia da química	2005
	Noção de natureza na química	2003
Quimcia e física	Influencia da física na química	1996
Quimica e literature	Raízes históricas do mal cientista	2006
Semiótica	Representações quimicas	1996
Sintese sobre a filosofia da química	Artigo sintese sobre a filosofia da química	1997
	Mesmo artigo de 1997 em polaco	1999
	Sintese da filosofia da quimica em alemão	2004
	Segunda ediçao do artigo de 1997	2006
	Tópicos em filosofia da química	2006
	Síntese sobre a Filosofia da química	2010
	Sintese sobre a filosofia da química	2003
Visualização	Imagem visual da quimica	2007

1.6.5.3 Produção de Paul Needham

Paul Needham				
2010	• "Substance and Time", , 61 (2010), 485-512.	*British Journal for the Philosophy of Science*		
	• "Making Theorem			
1976	"The Speaker's Point of View", 32 (1976), 309-27.	*Synthese*,		
1981	"Temporal Intervals and Temporal Order", , 93 (1981), 49-64.	*Logique et Analyse*		
1985	"Would Cause", *Acta Philosophica Fennica*, 38 (1985), 156-82.			
1988	"Causation: Relation or Connective?", 42 (1988), 201-19.	*Dialectica*,		
1989	"Spatio-Temporal Analogies" in Sten Lindström and Wlodzimierz Rabinowicz, eds., *In So Many Words: Philosophical Essays Dedicated to Sven Danielsson*, Philosophical Studies, Uppsala, 1989.			
1994	"The Causal Connective", pdf file in Jan Faye, Uwe Scheffler and Max Urchs, eds., *Logic and Causal Reasoning*, Akademie Verlag, Berlin, 1994.			
1995	"Tid" och "Tidslogik", , vol. 17, Bra Böcker, 1995.	*Nationalencyklopedin*		
1997	"Notes on Temperature", in L. Lindahl, P. Needham and R. Sliwinski, eds., *For Good Measure: Philosophical Essays Dedicated to Jan Odelstad on the Occasion of His Fiftieth Birthday*, Philosophical Studies, vol. 46, Uppsala, 1997.			
2000	"What is Water?", , 60 (2000), 13-21.	*Analysis*		
2000	"Hot Stuff", in Jan Faye, Uwe Scheffler and Max	Poznan Studies in the Philosophy of the		

	Urchs, eds., *Facts, Things, Events*, , Vol. 72, Rodopi, Amsterdam, 2000, 423-449.	Sciences and the Humanities		
1975	*Temporal Perspective: A Logical Analysis of Temporal Reference in English*, Philosophical Studies, Uppsala, 1975.		Analise temporal	
2006	• "Aristotle's Theory of Chemical Reaction and Chemical Substances", in Davis Baird, Eric Scerri and Lee McIntyre, eds., *Philosophy of Chemistry: Synthesis of a New Discipline*, Boston Studies in the Philosophy of Science, Springer, 2006; pp. 43		aristoteles	Teoria aristotelica da reaçao e substancia quimica
2004	"Generation and Destruction of Chemical Substances: An Exposition of the Aristotelian Conception", in Danuta Sobcynska, Pawel Zeidler and Ewa Zielonacka-Lis, eds., *Chemistry in the Philosophical Melting Pot*, in the series: Dia-Logos: Studies in Philosophy and Social Sciences, Peter Lang Europäischer Verlag der Wissenschaften, Frankfurt am Main, 2004: pp. 357-393.		aristoteles	Geração e desctruçºao de substancia quimica em Aristóteles
2009	An Aristotelian Theory of Chemical Substance", 12 (2009), 149	*Logical Analysis and History of Philosophy*,	Aristóteles	Teoria da substancia em aristoteles
2010	• with Alan Chalmers, Rom Harré and Eric Scerri, "A Revisionist History of Atomism", , 19 (2010), 349-71.	*Metascience*	Atomismo	Uma revisão histórica
2004	• "Has Daltonian Atomism Provided Chemistry with any Explanations?", , 71 (2004), 1038	*Philosophy of Science*	Atomismo	Atomismo daltoniano e explicação em quimica
2004	"When did Atoms Begin to do any Explanatory Work in Chemistry?", , 18 (2004), 199-219.	*International Studies in the Philosophy of Science*	Atomismo	Quando atomo explica na quimica
	Water and the Development of the Concept of Chemical Substance", in T. Tvedt and T. Oestigaard, eds., *A History of Water, Vol. 4: The Ideas of Water from Antiquity to Modern Times*, I. B. Tauris, London; pp. 86		Conceito de substancia	Desenvolvimento do conceito de substancia
2004	"Mixture and Chemical	*Foundations of*	Debate mistura e	

	Combination and Related Essays: A Response to Robert Deltete and Anastasios Brenner", , 6 (2004), 233-245.	*Chemistry*	modalidade	
2006	• "Ontological Reduction: Comment on Lombardi and Labarca", , 8 (2006), 73	*Foundations of Chemistry*	Debate redução	
2000	"Reduction in Chemistry: a second response to Scerri", , 14 (2000), 317-323.	*International Studies in the Philosophy of Science*	Debate reducionismo	Resposta a scerri
1996	"Macroscopic Objects: An Exercise in Duhemian Ontology", , 63 (1996), 204-223.	*Philosophy of Science*	dhuem	Ontologia duhem de objetos macroscópicos
1991	"Duhem and Cartwright on the Truth of Laws", 89 (1991), 89-109.	*Synthese*,	Duhem	
1996	"Aristotelian Chemistry: A Prelude to Duhemian Metaphysics", , 26 (1996), 251-269	*Studies in the History and Philosophy of Science*	Duhem	Aristoteliando quimcia
1996	"Substitution: Duhem's Explication of a Chemical Paradigm", 4 (1996), 408-33.	*Perspectives on Science*,	Duhem	Explicação de dhuem do paradigm da substituição
1998	"Duhem's Physicalism", , 29 (1998), 33-62.	*Studies in History and Philosophy of Science*	Duhem	Fisicalismo de duhem
2000	"Duhem and Quine", 54 (2000), 109-132.	*Dialectica*,	Duhem	
2002	"Duhem's Theory of Mixture in the Light of the Stoic Challenge to the Aristotelian Conception", , 33 (2002), 685-708.	*Studies in History and Philosophy of Science*	Duhem	Teoria da mistura
2002	Pierre Duhem, *Mixture and Chemical Combination, and Related Essays*, translated and edited, with an Introduction by Paul Needham, Kluwer, Dordrecht, 2002.		Duhem	Tradução de misturas e combinação química
2011	•with Michael Weisberg and Robin Hendry, "Philosophy of Chemistry", , first published on March 14, 2011. link	*Stanford Encyclopedia of Philosophy*	Síntese	Publicação na standford
2010	• with Michael Weisberg, "Matter, Structure and Change: Aspects of the Philosophy of Chemistry", , 5 (2010), 927-37.	*Philosophy Compass*	Filsofia da quimica	Material, estrutura e tempo
1993	"Stuff", , 71 (1993), 270-90.	*Australasian Journal of Philosophy*	Materia	
2010	"A Mereological Interpretation of the Phase Rule", , 77 (2010), 900-10.	*Philosophy of Science*	mereologia	Interpretação da regra das fases
1996	"Reconciling Micro- and		Micro e macro-	

	Macro-Perspectives" in Peter Janich and Nikos Psarros, eds., *Die Sprache der Chemie*, Könighausen und Neumann, Würzburg, 1996.		perspectiva	
2011	• "Microessentialism: What is the Argument?", 45 (2011), 1-21. pdf file	*Nous*,	Microessencialismo	
2005	• "Mixtures and Modality", , 7 (2005), 103	*Foundations of Chemistry*	Mistura e modalidade	
2007	• "Macroscopic Mixtures", , 104 (2007), 26	*Journal of Philosophy*	Misturas macroscópicas	
1986	"Gregg's Paradox and Cladistic Taxonomy" in Paul Needham and Jan Odelstad, eds., *Changing Positions: Essays Dedicated to Lars Lindahl*, Philosophical Studies, Uppsala, 1986.		Paradox da taxonomia cladista	
2011	Perre Duhem, *Commentary on the Priniciples of Thermodynamics*, translated, and with an Introduction by, Paul Needham, Series:, Vol. 277; Springer, Dordrecht. Due February 28, 2011.	Boston Studies in the Philosophy of Science	Duhem	Tradução de princípios termodinamicos
1999	"Macroscopic Processes", , 66 (1999), 310-331.	*Philosophy of Science*	processos	Processo macroscópicos
2003	"Continuants and Processes in Macroscopic Chemistry", , 14 (2004), 251-279. Reprinted in *Process Theories: Cross-Disciplinary Studies on Dynamic Categories*, ed. by J. Seibt, Kluwer, Dordrecht, 2003, pp. 237-65.	*Axiomathes*	processos	Processos em quimica macroscopic
2008	• "Is Water a Mixture?—Bridging the Distinction Between Physical and Chemical Properties", , 39 (2008), 66	*Studies in History and Philosophy of Science*	Propriedades quimica	
1987	"Underbestämning av underbestämningstesen: en jämförelse av van Fraassen med Poincaré, Quine och Cartwright", in Lennart Nordenfelt and Ingemar Nordin, eds.,*Vetenskap, etik, samhälle*, Linköping, 1987.		Quine	
1995	"Duhems quineska realism", , 16 (1995), 26-40.	*Filosofisk Tidskrift*	Duhem	Realism de duhem
2011	• "Duhem's Moderate Realism", in Anastasios Brenner, Paul Needham, David J. Stump and Robert Deltete, "New Perspectives on Duhem's *Aim and Structure of Physical*	*Metascience*	Duhem	Realism moderado de duhem

	Theory”, 20 (2011), 1-25.			
2004	• "Om reduktion", *Sats—*, 5 (2004), 69	*Nordic Journal of Philosophy*	Reducionismo	
2009	• “Reduction and Emergence: A Critique of Kim”, , 146 (2009), 93	*Philosophical Studies*	Reducionsimo emergencia	Critica a kim
2010	• “Nagel's Analysis of Reduction: Comments in Defence as Well as Critique”, , 41 (2010), 163	*Studies in History and Philosophy of Modern Physics*	Reducionismo	Analise da redução em nagel
2006	• "Om vatten och reduktion", , 27 (2006), 24	*Filosofisk Tidskrift*	Reducionismo	
2007	• with Robin Findlay Hendry, “Le Poidevin on the Reduction of Chemistry”, 58 (2007), 339	*British Journal for the Philosophy of Science*,	Reducionismo	
1999	"Reduction and Abduction in Chemistry: A Response to Scerri", 13 (1999), 165-180.	*International Studies in the Philosophy of Science*,	reducionismo	
2006	• “Substance and Modality”, , 73 (2006), 829	*Philosophy of Science*	Substancia e modalidade	
2010	• “Transient Things and Permanent Stuff”, 88 (2010), 147	*Australasian Journal of Philosophy*,	Substancia e processos	
1997	"Fleeting Things and Permanent Stuff", in Jan Faye, Uwe Scheffler and Max Urchs, eds., *Perspectives on Time*, , Vol. 189, Kluwer, 1997, 119-141.	Boston Studies in the Philosophy of Science	Substancia e processos	
2003	"Chemical Substances and Intensive Properties", 988 (2003), 99-113.	*Annals of the New York Academy of Sciences*,	Substancias quimicas	Propriedades intensives e o problema do reducionismo
	“Natural Kind Thingamajigs”,	*International Studies in the Philosophy of Science*, forthcoming	Tipos naturais	
2002	"The discovery that water is H20", , 16 (2002), 205-226.	*International Studies in the Philosophy of Science*	Tipos quimicos	Processos de determinação dos tipos quimicos

1.6.5.4 Produção de Jaap Van Brakel

TÍTULO	**REVISTA**	ÁREA	TEMÁTICA
On the inventors of XYZ, , 7 (2005) 57-84.	*Foundations of Chemistry*		
Chemical engineering science, pp. 509-523 in *Handbook Philosophy of Chemistry* (R.F. Hendry, P. Needham and A. Woody, eds), Boston: Elsevier (2010), in press.		Engenharia quimica	
Philosophy of Chemistry, University Press Leuven (2000). Reviews in: .	*The Philosophical Review*, *Erkenntnis*, *Journal for the General*	Filosofia da quimcia	Revises

	Philosophy of Science, Hyle, Metascience, Foundations of Chemistry		
Prehistory philosophy of chemistry, pp. 17-41 in *Handbook Philosophy of Chemistry* (R.F. Hendry, P. Needham and A. Woody, eds), Boston: Elsevier (2010), in press. Earlier version: On the neglect of the philosophy of chemistry, , 1 (1999) 111-174.	*Foundations of Chemistry*	Historia da filosofia da quimica	
Kant's legacy for the philosophy of chemistry, in volume 242 of the , Berlin: Springer (2006) 69-91.	*Boston Studies in the Philosophy of Science*	Kant	Legado de kant na filosofia da quimica
Substances: The ontology of chemistry, pp. 171-209 in (R.F. Hendry, P. Needham and A. Woody, eds), Boston: Elsevier (2010), in press.	*Handbook Philosophy of Chemistry*	Ontologia quimica	
Polywater and experimental realism, , 44 (1993) 775-784.	*British Journal for the Philosophy of Science*	realismo	Realism experimental
Chemistry and physics: No need for metaphysical glue, , 12 (2010) 123-136.	*Foundations of Chemistry*	Relação fisica quimica	

1.6.5.5 Produção de Rein Vihalem

ANO	TÍTULO	REVISTA	TEMA	
2011	'The Autonomy of Chemistry: Old and New Problems', 2011 (forthcoming) DOI: 10.1007/s10698-010-9094-5	Foundations of Chemistry	Autonomia da quimica	Realism prático
1980	'Concept of Scientificity and Social Determination of the Formation of a Science (on the Basis of the History of Chemistry)'. A.B. Bazhenov, M.D. Akhundov (eds.). Science in Social, Epistemological, and Axiological Aspects. Moscow: Nauka, 1980, pp. 345–358 [in Russian]. = Вихалемм, Р.А. (1980). Понятиенаучностиисоциальнаядетерминацияформированиянауки (наматериалеисториихимии). Баженов, Л. Б.; Ахундов, М. Д. (Отв. ред.). Наукавсоциальных, носеологическихиценностныхаспектах (345 - 358). Москва: Наука.		Cientificidade e determinação social	
2005	'Chemistry and a Theoretical Model of Science: On the Occasion of a Recent Debate with the Christies', 2005, Vol. 7, No. 2, pp. 171-182.	. Foundations of Chemistry	Debate	Quimica e o modelo teórico da ciência
2007	(Co-author P. Müürsepp) 'Philosophy of science in Estonia'., 2007, 38(1), 167 - 191.	Journal for General Philosophy of Science	Filosofia da ciencia	Filosofia da ciencia na estónia
2007	'Philosophy of chemistry and the image of science'. 2007, 12(3), 223 – 234	Foundations of	Filosofia da quimica	

		Science,		
2011	‘A. Whitehead's Metaphysical Ontology and I. Prigogine's Scientific Ontology: From a Point of View of a Theoretical Conception of Science’, 2007, 71, 78 - 90.	. Problemos	Filosofia de processos	whitehead
	‘Theoretical Philosophy and Philosophy of Science in the Soviet Times: Some Remarks on the Example of Estonia in 1960-1990	Studia Philosophica Estonica forthcoming)	Filosofia e filosofia da ciência	
2003	‘Are Laws of Nature and Scientific Theories Peculiar in Chemistry? Scrutinizing Mendeleev’s Discovery.’, 2003, 5, 1, pp. 7-22.	Foundations of Chemistry	Leis da quimica	
2005	‘Ostwald and the Methodology of Chemistry’. In: Görs, B.; Psarros, N.; Ziche, P. (Eds.). Wilhelm Ostwald at the Crossroads between Chemistry, Philosophy and Media Culture (1 - 11). Leipzig: Leipziger Universitätsverlag, 2005.		OSTWALD	Ostwald e a metodoloiga quimcia
	‘A Monistic or a Pluralistic View of Science: Why Bother?’ P. Stekeler-Weithofer, H. Kaden, & N. Psarros (eds.). An den Grenzen der Wissenschaft. (Abhandlungen der Sächsischen Akademie der Wissenschaften zu Leipzig. Philologisch-historische Klasse. Band 82, Heft 1). Stuttgart/Leipzig: Sächsische Akademie der Wissenschaften zu Leipzig. In Kommission bei S. Hirzel (forthcoming)		Pluralism em ciencia	Visão pluralista e monista
1974	‘Elaboration of the Philosophical Problems of Chemistry’. Voprosy Filosofii, 1974, No. 6, pp. 90–95 [in Russian, Summary in English, pp. 187–188]. = Вихалемм, Р.А. (1974). Оразработкефилософсихвопросовхимии. Вопросыфилософии, 6, 90 - 95.		Problemas filosóficos da quimica	
1982	‘The Dilemma of “Aprioristic Rationality” and “Historiographic Positivism” in the Western Philosophy of Science’. Voprosy Filosofii, 1982, No. 8, pp. 55-65 [in Russian, Summary in English, p. 174].= Вихалемм, Р.А. (1982). Дилемма «априорнойрациональности» и «историографическогопозитивизма» взападнойфилософиинауки. Вопросы философии, 8, 55 – 65.		Racionalidade aprioristica	
2011	‘Towards a Practical Realist Philosophy of Science’ Baltic Journal of European Studies, 2011, 1, 1(9), 46-60		Realism prático	
2005	‘On the conceptual systems of chemistry’ [in Russian]. In: A. A. Pechenkin (Ed.). The History of Science in the Philosphical Context. In Memory of V. I. Kuznetsov (1915-2005) [in Russian] (49 - 70). St.-Petersburg: RHGA, 2007. = Вихалемм, Р. (2007). Квопросуоконцептуальныхсистемаххимии. А. А. Печенкин (ред.). Историянаукивфилософскомконтексте. ПосвящаетсяпамятиВладимираИвановичаКузнецова (1915-2005) (49 - 70). СПб: РХГА.		Sistema conceitual da quimica	
200	‘Teaduslik teooria kui teadusfilosoofia kategooria’	Studia	Teoria	

9	(Abstract: Scientific Theory as a Category of Philosophy of Science). 2009, 2(1), 32-46.	Philosophica Estonica	cientifica	
2003	'Natural Kinds, Explanation, and Essentialism in Chemistry'. In: Joseph E. Earley, Sr. (ed.). Chemical Explanation: Characteristics, Development, Autonomy (Annals of the New York Academy of Sciences. Vol. 988). New York: The New York Academy of Sciences, 2003, pp. 59-70.		Tipos nataruais	Tipos naturais e essencialismo
2004	'The Problem of the Unity of Science and Chemistry'. In: Danuta Sobczynska, Pawel Zeidler, Ewa Zielonacka-Lis (eds.) Chemistry in the Philosophical Melting Pot (in series: Dia-Logos. Studies in Philosophy and Social Sciences). Frankfurt am Main: Peter Lang Europäischer Verlag der Wissenschaften, 2004, pp. 39-58.		Unidade da ciencia	Unidade da ciencia e quimica

1.6.5.6 Produção de Joseph Earley

ANO	TÍTULO	REVISTA	TEMA	
1998	"Modes of Chemical Becoming", Joseph E. Earley, Hyle, The International Journal for the Philosophy of Chemistry 4(2),1998. Published lectronically http://www.hyle.org/journal/issues/4/earley.htm	Hyle	processos	Modos de tornar-se
1998	"Naturalism, Theism, and the Origin of Life". Earley, Joseph E. Sr. , 27:3-4, 1998, 267-279	Process Studies	naturalismo	
2000	"Varieties of Chemical Closure." Joseph E. Earley, Sr. in Closure: Emergent Organizations and Their Dynamics, edited by Jerry L. R. Chandler andGertrudis Van de Vijer, Volume 901, Pages 122-131, , 2000.	Annals of the New York Academy of Sciences	Fechaturas qimicas	Variedades de fechaturas quimicas
2011	Review of By Parallel Reasoning: The Construction and Evaluation of Analogical Arguments by Paul Bartha, Oxford: Oxford University Press, 2010. Submitted to , at Cornell University, on September 15, 2011.	The Philosophical Review		

Anexo capítulo 2

2.1 - Questionário para os professores de licenciatura em química

Dimensões	Variável	Objetivo	Pergunta
Currículo de Química e humanidades	Filosofia e Química		Que relações considera que existam entre **Filosofia** e **Química**?
	Importância das humanidades	Explicitar compreensões sobre química e humanidades.	Em que medida o senhor (a) considera que o campo disciplinar de química tem alguma dificuldade de integrar as humanidades no curriculo de Química? e porque?
	Dificuldade de pensar e ensinar		Considera que exista alguma dificuldade de pensar a Química e portanto de ensinar? Quais?
	Implicações		E que implicações o senhor acha que tem para o pensamento curricular em Química?
	Especificidade da praxis		Em sua opnião, a química tem alguma especificidade que diferencia outras outras ciencias? Se sim, poderia explitar?
Debate	Conhecimento do debate		Tem conhecimento sobre o debate do campo emergente campo disciplinar da filosofia da Química
	Forma do conhecimento		Como conheceu? ( ) congresso ( ) artigo ( ) curso ( )
	Principais temas		Que temas principais tem atraído a sua atenção?
Relevância da Filosofia da Química	Relevancia para o currículo	Conhecimento de posições macrocurriculares com a F. Q	Em que medida você acha importante a Filosofia da Química para pensar o currículo de Química como um todo?
	Relevancia para o ensino	Recolher informações sobre o conhecimento de implicações para o ensino	Em que medida considera relevante o debate sobre a Filosofia da Química para o ensino?
	Relevância e investigação	Recolher informações sobre o conhecimento de implicações sobre a investigação	Em que medida considera relevante o debate sobre a Filosofia da Química para investigação em Educação Química?
Relações da Filosofia da Química	Relevancia para pesquisa em quimica		Qual a relevancia da filosofia da química para a persquisa em quimica?
	Relações com subáreas	Conhecimento das relações com as subáreas.	Qual das subáreas de Química o senhor acha que se relaciona mais com Filosofia da Química?
Integração da Filosofia da Química	Casos de integração		Conhece casos de integração da filosofia da química no currículo?
	Forma de		Em sua opinião, a integração desta temática

	integração		deveriam se dar na forma de uma disciplina ou de forma transversal no currículo?

Anexo do capítulo 3

3.1 Caracterização da química pelos filósofos da química

	"Since Geoffroy chemistry has wavered between two problematics: a science of matter or a science of reactions." (Guédon 1980, p. 103)	Substancia ou processos
wiberg (2004)	Studies of the related subjects of strain, structure, stability and reactivity represent one of the major areas of chemistry. The other is concerned with synthesis, or the preparation of molecules having specific structures. At the beginning, i will give brief definitions of these concepts, and then each will be examined in the context of the chemistry of small rings. They are compounds that contain three of four membered rings, and frequently have properties quite different than compounds that have larger rings. These differences in properties force us to think in more detail about the concepts indicated above.	Substancias
Tontini	Chemistry, whose fundamental cognitive aim is to understand how the structure of molecules determines the properties of natural substances and composite material systems	Substancias
Schummer, 1998	Chemistry is the most general science of materials,	Substancias
Tontini, 1999	Chemistry (and molecular biology) perceives the deepness, the inexhaustibility of matter in terms of the potentially infinite number of substances, which could be prepared, and of the organizational complexity of its microscopic components	Substancias
Lefreve, 2011	As ursula klein's Contribution to this special issue elaborates, chemistry is first and above all the science of a Huge kingdom of material substances.	Substancias
Schummer, 1996	Presents the foundations of an ordering of 'stuffs', i.e. Chemical substances, that allow the pursuit of the synthesis of new stuffs	Substancias Propriedades materiais
Van Braquel	Uma ciência das substâncias	Substancias e processos
Laszlo, 1997	Chemistry is routinely defined as the science of the transformations of matter	Substancias e processos
Lefreve, 2011	Adequately recognized fact that chemistry was and is first of all a science—not of matter— but of concrete substances, of materials, and, as it were, of an overwhelming amount of different materials already in the seventeenth and eighteenth centuries	Substancias em particular
Tomasi, 1999	Chemistry is the science of subtle differences among similar material systems	Subtancias
Lefreve, 2011	Here we Encounter the core of the essentially techno-scientific character of chemistry to which Ursula Klein has alerted us7—chemistry's techno-scientific character which, indeed, predates The modern chemical industry as it emerged in the second half of the nineteenth Century: Chemists cannot study the substances under investigation by means of chemical Reactions without producing new substances.	Tecnociencia
Lefreve, 2011	In turn, chemistry became more and more a pre-requisite condition of these Productive branches as a technology, that is, as a science that studies technical processes and procedures as well as the possibilities of their improvement	Tecnologia
Benfey (2000)	The philosophy of chemistry is centered on affinity, cohesion, the architecture of the very small, attraction, harmony, and, if you permit, beauty. Our discipline is the voice of the twenty-first century, a message, a clarion call of life, of hope.	Valores; beleza, harmonia Afinidade, , coesão
Lefevre, 2011	Practices of classifying are, indeed, essential for chemistry because it is a science that deals with hundreds of thousands of different substances that must be identified and ordered in one or another taxonomic frame	Classificação
Laszlo, 2011	Let us start, perhaps, with chemistry defined as the science of the	Substancia:

	transformations of matter	transformação de substancia
Laszlo, 2011	Another person may define chemistry, instead, as the science of the artificial. This leads to an engineering and computational outlook. What comes to the fore, from such a viewpoint, is how to assemble entities such as atoms or molecules into other entities, supramolecular assemblies aimed at nanotechnologies for instance (Johnson 2009).	Ciencia do artificial: supramolecular
Laszlo, 2011	To a third person, chemistry will be, primarily, the molecular science. Which translates into a predominant focus on bonding, structure, systematics of molecules ordered by families, design and targetting of new molecules, then obtained by synthesis.	Ciencia molecular: estrutura das moléculas
Laszlo, 2011	There are yet other definitions of chemistry: to postmodern historians and philosophers of science, it is a technoscience;	Tecnociencia: definição pos-moderna
Laszlo, 2011	chemistry may be viewed, alternatively, as a combinatorial art (a point I shall return to in this paper)	Linguagem, arte combinatorial
Laszlo, 2011	to other people, of an industrial bent, it is the science of innovation;	Criativa: inocação, ligada a industria
Schummer, 2010	Because chemistry is about radical change, it needs to deal with fundamental problems,	Processos: mudanças
Schummer, 2010	many argue that chemistry is ultimately about atoms and molecules rather than about substances	Substancias e moléculas
Psarros, 1998)	"La Química es el estudio de los elementos y de los compuestos que estos forman y sus transformaciones. La química se ocupa principalmente de los efectos que dependen de los electrones más externos de los átomos"	Substancia: transformações
(Van Lier, G., 2002)	Es muy conocido que la química es la ciencia central, teniendo a un lado la física y las matemáticas, y del otro lado la biología, la geología e incluso algunas ciencias sociales relacionadas.	Ciencia central
Vihalemm, 2007	Chemistry investigates particular kinds of substances (stuffs) and their transformations. Then the primary tasks of chemistry are the identification and classification of substances and of their modes of transformation	Classificação

3.2 Interlocuções com a comunidade internacional

Data local	Participantes	Conteúdo
UBA – Universidade de Buenos Aires – 16/05/2011. Apresentado no período de reunião do grupo de investigação em epistemologia e didática. O período de apresentação foi de 90 minutos entre aprensentação e discurssão	Professor doutor, didata da ciencia e professora doutora em Filosofia e 4 alunos de doutoramente em Filosofia e História da Ciencia	Campos estruturantes da Filosofia da química Dimensões da *Praxis* Química Relações com o currículo
Grupo de ensino de química - UFBa 16/06/2011	Quatro professores de didática da Química. Dois com doutorado em Educação e dois cursando o doutorado em Educação	Campos estruturantes da Filosofia da química Dimensões da *Praxis* Química Relações com o currículo
Buenos Aires - 22/05/2011	Discursão com filósofos da química	As dimensões da Química
Apresentação do 11^{0} IHPST – Grécia/Thessaloniki, 5-	Discussão com educadores quimicos	As dimensões da *praxis*

7/07/2011		
Disciplina fundamentos da quimcia - UFBa 15/09/2011	Professores doutores em ensino de Ciencias e três alunos de mestrado em educação científica	As dimensões da *praxis*
Congresso de Filosofia da química 11/08/2011	Discussões a partir da apresentação	As dimensões da *praxis*
Vários encontros	Professor doutor em educação da UFBa	As dimensões da *praxis*
Vários encontros	Professor doutor em educação da UP/Portugal	As dimensões da *praxis*
06/2011	Porfessor, doutor em fisica-química da UC-Portugal)	As dimensões da *praxis*
02/11 a 05/11	Disciplina Didática II – UP/Portugal	A *praxis* como fundamento didático
7-10/08/2012	ISPC 2012 – Trabalhos apresentados	Filosofia da química como fundamento do currículo
17-20/07/2012	ENEQ – Minicurso apresentado	Filosofia da química como fundamento do currículo

Data local	Participantes	Conteúdo	Reação
UBA – Universidade de Buenos Aires Foi Apresentado no período de reunião do grupo de investigação em epistemologia e didática do professor Agustin Aduriz-Bravo O período de apresentação foi de 90 minutos entre aprensentação e discurssão	Professor Agustin Aduriz-Bravo, professora Ana Colou de formação em Filosofia e 4 alunos de doutoramente em Filosofia e História da Ciencia	Campos estruturantes da Filosofia da Química Dimensões da Praxis Química Relações com o curriculo	Muitos assuntos juntos. Muita novidade. Na Colou que é Filósofa disse que gostaria de ter mais distanciamento para analisar. **Comentário do doutorando Yefrin Ariza**: Localizar os problemas **Comentário do professor Agustin** Separar valores do conhecimento tácito. A dimensão tácita é transversal à todas as dimensões. Pode separar os três campus primeiros para espaço micro curricular porque ele mesmo considera que os três primeiro são dedicados a explicação científica e os outros para a mudança e progresso científico. Assim, os outros três são para o pensamento curricular. A dificuldade conceitos epistémicos se relaciona mais com seleção e organização de conteúdos E a dificuldade de identidade disciplinar mais com o desenvolvimento curricular. Considerar a fenomenotécnica com a dimensão pragmática Considerar a dimensão diagramática com a retórica A classificatória com a lógica A relacional não tem ainda uma consideração a ser feita. A valorativa com a ética e também a axiologia. Colocar as subdisciplinas de Química geral e química biológica. A taxonomia de conteúdos proposta por zabala é muito superficial ao considerar apenas conteúdos conceituais e não conceituais. Tem que se considerar outras taxonomias. (penso que também a taxonomia de Anderson também é

			incompleta, quais outras seriam melhores?) Tenho que fazer uma aproximação naturalísticas a cerca dos problemas, do campo de problemas da Filosofia da Química e não tentando emitir juízos de valores a cerca da diferença entre Química e Fisica e Biologia, pois se mostrar alguma diferença tem que provar. A melhor forma é aproximar-se pelos problemas. Fazer uma aproximação naturalística sobre os problemas relatados pela filosofia da Química. Agustin acha que a única diferença entre física e Química é relativo ao campo de valores e finalidades. Que os aportes da didática específica são aportes da didática geral das ciências aplicadas a didática especifica. Que o que existe são problemas ultraespecíficos aplicados a didática especifica. Considerações de Rafael No Brasil há um enfoque muito pedagógico no ensino de ciências Ensino de ciências. Enfoque na sala de aula, na prática Didatica das ciências: disciplina científica com métodos, fundamentos teóricos, epistemológicos Educação científica: questões maiores da pedagogia, No Brasil há um enfoque ou no ensino de ciências ou na educação científica e pouco enfoque na didática das ciências.
UFBa	Estavam presentes 4 professores de didática da Química sendo dois com doutorado em Educação e dois cursando o doutorado em Educação	Campos estruturantes da Filosofia da Química Dimensões da Praxis Química Relações com o curriculo	Todos disseram que a temática é nova e que tinham pouco a contribuir, que ainda não tinha pensado sobre aqueles assuntos. O professor Nelson Bejarano elogiou e disse que já evolui bastante deste o último encontro. A professora soraia lobo disse que sentia falta da dimensão da prática do Químico e que sente esta ausência nos currículos. Eu argumentei que os filósofos da Química são Químicos também de profissão e que este debate reflete o que é Química. Bernadete Achou muito produtivo a relação final que eu faço das dimensões com as disciplinas. O professor Edilson colocou da importância que é a pesquisa da praxis.

Buenos aires Encontro com o professor labarca e a professora Olimpia		As dimensões da Química	A professora Olimpia Lombardi colocou que sentia ausência da dimensão histórica no esquema que montei. Eu contra-argumentei que o próprio conceito de praxis já esta incluso a dimensão história. Ela considerou importante e inovador esta classificação O professor labarca também disse que so tinha a acrescentar esta dimensão da história e que sua especialidade é sobre ontologia Química e não gostaria de falar sobre outros assuntos.
Conversa com professor chamizo	No encontro do IHPST		O professor salientou que o estudo das dimensões é muito grande, e que deveria preocupar-me com a questão metodológica. Como cheguei aquelas dimensões e não outras? Pois qualquer um poderia propor outras dimensões. Como justificar e fundamentar em evidencias estas proposições?
Conversa com os professores Valdmir Araújo Neto	No encontro do IHPST		O professor disse que é muito extenso a temática e que deveria focar mais em um tema. Contudo, na mesma conversa, uma pesquisadora Diana, contra argumentou e disse que a proposta é muito boa e que aproximar da praxis Química é muito inovador.
Diana	E-mail enviado		Leyendo tu propuesta me encanta la forma como articulas esas cinco "identidades" de la química a través de 5 pensadores distintos, creo que como aporte base es fundamental en tu trabajo y queda perfectamente comprendido y explicado en la Figura 4. No obstante, aún no me parece clara la relación que hay entre estos 5 elementos y el modelo de los campos teóricos estructurantes de Áduriz-Bravo, yo considero que tu propuesta se sostiene por sí sola en la pluralidad de "identidades" de la química que presentas. De otro lado se ve muy clara la relación entre tu trabajo y la implicación didáctica: "Cómo pensar y enseñar consistentemente esa pluralidad constitutiva (p. 600)", así como las ideas del último párrafo del paper. No sé si lo has considerado pero sería interesante, si la idea es llevar esto hasta el nivel curricular, analizar contenidos curriculares de diferentes contextos para evidenciar la predominancia o no de estas dimensiones del conocimiento químico, eso soportaría un poco la relación entre el paso del discurso filosófico al del aula. Como te dije el día después de la presentación considero muy interesante tu trabajo, no obstante, debo recomendarte que mandes revisar el paper porque está

			lleno de errores con el inglés, hay incluso palabras que no fueron traducidas, además hay muchos problemas con las citas bibliográficas: paréntesis vacíos sin las fechas, citas que no aparecen en la bibliografía como los trabajos de Harre, entre otras cosas.
Apresentação em congresso			
Apresentação da disciplina da UFBa	Estavam os professores José luís de Paula, Edilson Moradilho, Maria Bernadete, e três alunos de mestrado		Foi dado um texto de 23 páginas e eles leram e fizeram considerações. A reação foi de surpresa quanto a temática, nenhum deles tinha ainda tido contato com a temática. O texto gerou muita discursão, dentro da temática e fora da temática por mim abordada. No final, o professor da disciplina, Jose Luis, considerou uma boa intervenção e contribuição. Todos consideram o tema de muita relevância, explicitar os elementos da praxis constitue um problema de suma importância para a Educação Química. Quanto as 5 dimensões, nem um dos participantes foi explícito a críticas. Consideram que apresentar um filósofos como representante da dimensão é reduzir a contribuição deste, sendo melhor colocar na argumentação do texto, bem como a contribuição de outros. O professor Jose Luis de Paula acrescentou que o meu texto estava muito impreciso, era muito didatico para filósofos e muito filosófico para didáticos, sem assim, ter um foco muito preciso. Acrescentou também que o texto deixa implícito um valor muito grande de fundamentação e regulação a Filosofia, função que o mesmo não considera tão importante. Ele não considera que a Filosofia deva ter tanta importância assim nos currículos, nem mesmo nos currículos de Filosofia. Para o professor Edilson o texto pode incorrer no risco do amplo ecletismo entre os autores, variados autores e como mostrar coerência teórica entre os variados autores? O professor Edilson também salientou que os educadores Químicos tem trabalhado com o triangulo, (teórico, fenomenológico e representacional) e gostaria de saber qual a diferença da minha contribuição. Eu respondi que estas dimensões são campos de problemas da praxis Química, que em

			todas podem ser encontradas as relações teóricas, fenomenológicas e representacionais. Para o professor José luiz de Paulo não esta claro e nem ele considera importante a diferenciação entre conceitos, representações e relações. Para o professor Fábio a depender de como uso o termo conceito ele pode também ser considerado uma representação. Para este argumento eu expliquei que estava fazendo a diferença entre os conceitos de equilíbrio, estabilidade, permanência como conceitos primitivos da Filosofia e o conceito de representações como uso de diagramas. Apesar de não haver acordo, mas houve considerações positivas. O professor Edilson levantou atenção para a própria situação da Filosofia na atualidade. O professor Jose luís situou um trabalho feito sobre classificações e citou os três tipos de classificações que ele considera. Todos levantaram a questão de que nenhuma dimensão pode representar a praxis Química isoladamente.
Congresso de Filosofia da Química	Discussões a partir da apresentação		Todos os filósofos da Química entenderam que esta temática ainda é bastante nova e ainda não tem pessoas pesquisando sobre este assunto.n O professor Eric Scerri aconselhou retirar os nomes de autores do esquema, pois existem muitos outros também representativos, construir no texto estes autores e muitos outros que relacionam esta temática. O professor Waldimir e o professor chamizo também concordaram com este argumento. O professor Chamizo argumentou que seria melhor eu focar em uma dimensão e explorar em profundidade, contudo eu contra argumentei que o objetivo era fazer uma primeira aproximação ao tema. O professor Waldimir entendeu que meu objetivo era fazer uma fotografia da temática, do que tem sido discutido, sem entrar em detalhes maiores. O professor Harre colocou a cerca da ausência da dimensão Histórica e eu coloquei que o próprio conceito de praxis já é histórico, contudo ficou concensuado da necessidade de explicitar uma dimensão

			histórica e também os valores, relacionar as questões da ética. O professor Klaus Guttemberg entendeu que o que eu estava fazendo era uma teoria sobre esta temática O professor Schummer argumentou que o esquema oferece uma aproximação muito distanciada da Química e muitos conteúdos ficam de fora e perguntou como integrar e contextualizar os conteúdos? Como os professores se beneficiariam deste esquema? Como deduzir metodologias a partir deste esquema? O professor Andres Bernal disse que o esquema é muito geral e não capta as especificadades de toda a química. Outro professor disse que o esquema é mais para a Química microscópica do que para a Química microscópica, onde estaria a Quimica macroscópica no esquema?

3.3 Artigos por dimensão no journal of chemical education

Tabela 5: Número de artigos na revista JCE referente ás dimensões da praxis química

Dimensao	Entrada	Número de artigos
Diagramática	Modeling	3293
	Diagrammatic	2340
	Diagrammatic AND learning	51
	Diagrammatic AND Teaching	91
	Diagrammatic AND Didactic	11
	Diagrammatic AND Education	141
	Visualization	2140
	Visualization AND Diagrammatic	71
	Representation	93341
	Diagrammatic AND Semiotic	0
	Diagrammatic AND Peirce	0
	Representation AND Semiotic	3
	Diagrammatic Thinking	0
	Semiotic	3
	Semiotics	5
	Diagram AND philosophy	1415
	Philosophy of language	2
	“Philosophy of signs”	0
	“philosophy of image”	1
	Semantic	790
	"representational competence"	11
	Linguistic	615
	Linguistic AND peirce	1
	Diagrammatic reasoning	1
Tácita	Tacit	851

	“Tacit knowledge”	15
	“tacit Knowledge” AND Polanyi	3
	Heuristic	186
	Discovery	74987
	Laboratory	419336
	Discovery AND Philosophy	1946
	“Philosophy of heuristic”	0
Classificatória	Classification	33792
	Classifications	5117
	Classification AND duhem	104
	“Philosophy of classification”	5
	“natural philosophy” AND classifications	39
	Classify	10120
Processual	Process	549290
	Process AND philosophy	6924
	prigogine AND philosophy AND process	35
	“philosophy of process”	5
	Relations	42737
	“Internal relations”	16
	“process ontology”	11
	Whitehead AND philosophy AND process	16
Fenomenotécnica	Phenomenothecnical	0
	“philosophy of instruments”	0
	Instruments	132895
	Instruments AND philosophy	369
	Measure AND philosophy	3860
	Measure	233200
	“philosophy of experiment”	1
	Technical	5
	Technique	281348
	Phenomenotechnique	0
	Bachelard AND philosophy	5
	Philosophy of laboratory	4

3.4 Parecer de revisores dos trabalhos apresentados

3.4.1 - Enpec

O trabalho traz contribuições importantes na interface entre filosofia da química e educação química. Aponto, contudo, pontos a revisar, de modo a tornar mais forte seu argumento. Os autores precisam colocar o trabalho de acordo com as normas do VIII ENPEC. O mesmo não apresenta, por exemplo, abstract. O artigo também ultrapassa as 12 páginas recomendadas. Ele deve ser diminuído de modo a se limitar ao tamanho indicado. É preciso revisar, também, a redação do artigo, que apresenta problemas de concordância, ortografia, acentuação, pontuação. Na p. 2, faz-se referência a uma **“epistemologia tradicional”.** A expressão tem significado vago. Melhor seria designar explicita e claramente as correntes filosóficas das quais se está falando. Mais à frente, temos: “epistemologia tradicional (positivista), principalmente a partir da concepção herdada da filosofia da ciência (dominada pelo positivismo lógico) e que, na Química, tem em Bachelard o seu principal aporte, pelo menos no contexto do Brasil.” Era Bachelard um positivista e, ainda mais, um positivista lógico? Não me parece que esta qualificação possa ser sustentada, devendo ser revista pelos autores.

Além disso, falta que tragam um argumento de por que o positivismo lógico é insuficiente, que vá além da usual referência ao positivismo como corrente filosófica negativa, sem que se reconheçam suas contribuições e possibilidades, nem se demarquem seus limites. É ingênua a posição que considera que basta dizer que algo é positivista para que seja negativo. Se tem limites o positivismo, quais são eles? É preciso argumentar a respeito, não

apenas repetir um cantochão anti-positivista que atravessa o campo da pesquisa em ensino de ciências de modo não argumentativo, logo, praticamente doutrinário.

Na p. 3, contudo, aparecem tais argumentos, mas estranhamente não são referidos explicitamente como uma crítica ao positivismo lógico. p. 2: “fechatura”. Não seria “fechamento”? p. 3: “opinião de Kant”. Era mera opinião ou parte de seu sistema filosófico? p. 3: “a Química distingue-se das outras ciências por criar o seu objeto, por inspirar um pensamento próprio aos seus praticantes”. Mas isso não é específico da química! Outras ciências criam seus objetos e todas as ciências inspiram “pensamento próprio” aos seus praticantes. p. 3: “As suas raízes históricas no pragmatismo”. Em que sentido do termo “pragmatismo”? p. 5: “critérios racionais de selecção e organização de conteúdo”. Há que se definir a expressão. “Racionais” em que sentido? p. 5: Explicar os conceitos de “nomotético”, “ideográfico”, “pan-nomotético”... p. 6: A figura 1 é de difícil visualização e é chamada no texto de modo inadequado, sem conexão clara com seu conteúdo. p. 6: “Os três primeiros campos epistemológicos guardam maior relação com o processo de ensino/aprendizagem e com os obstáculos conceituais e epistemológicos.” Quais? Como a figura é chamada de modo inadequado no texto e não é devidamente explorada, fica difícil o leitor entender de quais campos se está falando. p. 6: Muitos termos devem ser explicados para tornar possível a compreensão do leitor: Modo 1, Modo 2, pós-acadêmica, praxiologia. Como o texto é maior do que o tamanho recomendado e a compreensão do leitor deve ser priorizada, os autores devem retirar parte do argumento, de modo a colocar o texto no tamanho recomendado e torná-lo mais compreensível. p. 7: Aparece uma Tabela que não tem título e não é chamada no texto, o que é inadequado. p. 8: von Helmholtz e não Helmotz. p. 8: Antes, argumenta-se sobre grande ênfase sobre teorias e leis na compreensão da química como ciência, em decorrência da influência de uma filosofia da ciência que era, sobretudo, uma filosofia da física. Nesta página, então, discute-se a superação do ensino descritivo da química por um ensino fenomenotécnico, no qual não há espaço para a teoria, apenas para reprodução. Há, pois, uma tensão entre os dois argumentos, que convém que os autores busquem resolver ou, ao menos, argumentar no sentido de possível resolução.

Temos, ainda: “O que interessa é que este ensino ainda usa muito os conteúdos procedimentais, fruto da grande extensão da influência da Física sobre a Química.” O que a física e sua filosofia suscitaram: ênfase sobre teorias ou sobre algoritmos? Ou sobre ambos? E que tensões há aí? p. 9: “A dimensão tácita e a questão dos valores são também contempladas pela linha CTSA dos currículos, contudo estes currículos partem apenas da ideia de contextualização e de temas geradores nos contextos sociais significativos, não problematizando a partir dos conteúdos.” Não me parece que temos aí caracterização justa dos currículos CTSA. Há vários que são problematizadores, como aqueles que tomam por base a tomada de decisão socialmente responsável sobre questões sócio-científicas.Por exemplo: SANTOS, W. L. P.; MORTIMER, E. F. Tomada de decisão para ação social responsável no ensino de ciências. Ciência e Educação, v.7, n.1, p.95-111, 2001. p. 10: “Apresentamos neste artigo uma primeira aproximação, já que os cinco registos foram ensinados e discutidos nas aulas da disciplina e só no fim do corrente ano lectivo é que se poderá “medir” o efeito de tal aprendizagem na reestruturação do pensamento químico e só durante o próximo ano lectivo é que poderemos observar o efeito que terá na prática lectiva dos alunos....” Mas nada foi dito sobre proposta pedagógica, fez-se uma revisão da literatura sobre filosofia da química! O artigo parece construído por recorte de texto maior, sem o devido cuidado. É preciso revisão cuidadosa para que o artigo possa ser publicado nas Atas do ENPEC. p. 11: “Uma epistemologia construtivista (Costa Pereira, 2007, p 99-111) em oposição à positivista, inspirada no defunto positivismo lógico do Círculo de Viena em que a Ciência aparece como projecto e não objecto do conhecimento” Ora, o que se espera de um texto acadêmico não são panfletos, mas argumentos. Que se reconheçam os limites do positivismo lógico não implica que não reconheçam suas contribuições. Não se deve naturalizar uma epistemologia construtivista em si mesma controversa como se fosse solução de todas as coisas. Não se deve ver no positivismo lógico meramente um defunto. Como argumenta van Fraassen, em A Imagem científica, ainda que, como resultado o positivismo lógico não tenha tido sucesso, como desenvolvimento ele o teve, contribuindo para o avanço da filosofia da ciência no século XX. Já é tempo da literatura em ensino de ciências superar essa visão simplista e doutrinária do positivismo. Caso os autores tenham algum interesse em compreender a amplitude do positivismo lógico, recomendo: Reisch, G. A. 2005. How the Cold War Transformed Philosophy of Science: To the Icy Slopes of Logic. Cambridge U.P. p. 11: “Um discurso contrastante com o Cartesiano”. Do mesmo modo, que não se perca de vista as contribuições do cartesianismo, no afã de apontar seus limites. Há muitos trechos que demandam que fontes sejam citadas, mas os autores não o fizeram: “acabou por ser responsável pela imagem de “coleccionadores de selos e aquecedores de panelas” que os químicos, durante séculos, tiveram nos círculos filosóficos.” “Ao nível do Brasil, que é a segunda maior comunidade de Químicos do Mundo” “é a ciência mais produtiva” – Mais do que a medicina? Onde

estão as fontes ou os dados em apoio a esta afirmação? (Gois, 2005?) – Por que a interrogação? “A dimensão tácita e a questão dos valores são também contempladas pela linha CTSA dos currículos, contudo estes currículos partem apenas da ideia de contextualização e de temas geradores nos contextos sociais significativos, não problematizando a partir dos conteúdos. Na Química a dimensão tácita é uma dimensão que merece ser fortemente investigada, pois a génese e o significado de muitos conceitos Químicos têm relação com a dimensão prática e são regulados por valores como a utilidade e aplicações. A dimensão processual ainda não foi explorada no ensino de Química, mas as noções de mapas de reações, redes reacionais e níveis podem oferecer muitos “insights” para a prática Química.” Faltam fontes para cada abordagem tratada no parágrafo. Por fim, os autores devem rever o uso de figuras no artigo. Há figuras que não são mencionadas no texto, como a 5 e a 6. São necessárias? Retirar figuras pode ajudar o artigo a ser colocado na dimensão recomendada nas normas do congresso. A numeração das figuras também está equivocada, pulando-se da 2 para a 5 e a 6. ¬---------- Recomendação: Aceito ( ) Aceito com pequena revisão (X) Recusado ( ) ¬---------- Nota do trabalho: (2) 4 - Trabalho aceito sem ressalvas 3 - Trabalho aceito com até três ressalvas 2 - Trabalho com mais de três ressalvas, mas aceito (tem contribuições para a área e merece ser discutido) 1. Trabalho recusado

Formulário para Avaliação de Trabalhos Teóricos A PRAXIS QUÍMICA COMO FUNDAMENTO DIDÁTICO PARA A QUÍMICA 1) O problema teórico abordado é relevante para a pesquisa em Educação em Ciências? (X) Bom ( ) Regular ( ) Fraco Comentário: Ver comentários do árbitro, abaixo.---------- 2) A fundamentação teórica é adequada para abordar o problema? (x) Bom ( ) Regular ( ) Fraco Comentário: Ver comentários do árbitro, abaixo. 3) A pesquisa dialoga com trabalhos pertinentes da literatura? ( ) Bom (X) Regular ( ) Fraco Comentário: Ver comentários do árbitro, abaixo 4) O argumento desenvolvido é claro e consistente? ( ) Bom (X) Regular ( ) Fraco Ver comentários do árbitro, abaixo 5) As conclusões estão ancoradas nas discussões e incluem recomendações para a área? ( ) Bom (X) Regular ( ) Fraco Comentário: Ver comentários do árbitro, abaixo. ¬---------- Comentários e sugestões do árbitro, incluindo razões para aceitar ou rejeitar a contribuição

O trabalho identifica um problema relevante para a área, dialoga com a literatura e propõe conclusões. No entanto, o texto em si não está escrito de maneira clara, em termos da argumentação desenvolvida. Colabora muito para isso a redação um tanto quanto falha. Prejudica a compreensão do leitor o fato de que as frases em geral são muito longas. Há vários erros de ortografia e de digitação, de modo que o texto precisaria passar por cuidadosa revisão. Em alguns trechos faltam referências. Numa das primeiras páginas, por exemplo, está, sem o complemento de onde a informação foi retirada: “Bensaud-Vicent tem identificado que ...”. Devido a esses fatores sugiro que o trabalho seja aceito com revisões. ¬---------- Recomendação: Aceito ( )

Aceito com pequena revisão (X) Recusado ( ) ¬---------- Nota do trabalho: (2) 4 - Trabalho aceito sem ressalvas 3 - Trabalho aceito com até três ressalvas 2 - Trabalho com mais de três ressalvas, mas aceito (tem contribuições para a área e merece ser discutido) 1. Trabalho recusado

3.4.2 Science education

Dear Marcos Antonio Pinto Ribeiro,

We have received the reports from our advisors on your manuscript, "Constitutive Pluralism of Chemistry: thought planning, curriculum, epistemological and didactic orientations", which you submitted to Science & Education

Based on the advice received, I feel that your manuscript could be reconsidered for publication should you be prepared to incorporate major revisions. When preparing your revised manuscript, you are asked to carefully consider the reviewer comments below, and submit a list of responses to the comments.

If one or more reviewers have uploaded files related to their reviews, these files can be found online.

In order to submit your revised manuscript, please access the following web site:

Your username is: marcolimite

Your password is: ma049104

We look forward to receiving your revised manuscript within ight weeks.With kind regards,

Michael R. Matthews

Editor in Chief

COMMENTS FOR THE AUTHOR:

Science & Education

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July 19th, 2011

SCIENCE & EDUCATION SUBMISSION

Dear Dr Marcos Antonio Pinto Ribeiro

Thank you for submitting your paper:

"Constitutive Pluralism of Chemistry: thought planning, curriculum, epistemological and didactic orientations" (SCED762)

to Science & Education for possible publication in the 'Philosophy and Chemistry Teaching' special issue being guest-edited by Professor Sibel Erduran.

The paper has been reviewed by three scholars and their reviews follow below. The reviewers differ in their evaluation of your paper. Two believe that it could be accepted after revision, and one thinks that it should be rejected. The reviews list the issues they have identified.

Having re-read the mss and the reviews, the guest editor and I believe a REVISION judgement is appropriate. Please re-work the manuscript and address all the points made in the reviews. Please go over all the critical points mentioned and give considered responses to them. You do not have to agree with them all, but you do need to respond to them

Apart from the referees' comments, we would like to suggest that the focus of the paper is made clearer with respect to the detail on the philosophical contributions to "chemical dimensions on teaching." Although related ideas are reviewed, it is not entirely clear what precisely the philosophical contributions are. These may already be implicit in the concepts covered. However they need to be made more explicit and presented in a more convincing manner so that they are accessible to the international and interdisciplinary readership of the journal.

The resubmitted article should include a separate sheet detailing each of the reviewer's recommendations and how you have responded to them. Where you disagree with the reviewer's comments you need to explain your reasons. Scholars can of course disagree over both matters of fact and of interpretation, but when reviewers have made detailed criticism, then the review process requires that these be dealt with - they need not be agreed to, but they do need to be engaged with and answered.

Please check that all references cited in the paper are included in the bibliography, and are in the style used in the journal - initials only, not full first names, no brackets around the date of publication, book and journal titles in italics not underlined, and so on. The journal's reference style is that used in all Springer publications: surname, initials, colon, date, book or article title, etc.

Also please follow exactly the Science & Education format for title, ABSTRACT, references, headings, etc. Could I repeat EXACTLY, as this greatly reduces subsequent work. Please place the article title, your name, address and Abstract in the position and form used in the journal - title in bold and flush left, author's name in capitals and flush left, address on new line, in italics and flush left. Please also follow the format for headings - flush left, upper and lower case words, bold, not underlined. Sub-headings are capitalised, not underlined, and not bold. Also please follow the format for indentation of paragraphs - no indentation immediately after headings, and sub-headings, indented thereafter.

Also please check that all punctuation marks are placed outside of inverted commas - the Chicago Style Manual is definitely not being followed in this regard. For example, if giving a list of words with four letters, write it as follows: 'soon', 'mail', 'four', not 'soon,' 'mail,' 'four,'. The inverted commas designate a word, not a word plus punctuation.

In Reference List, please capitalise all major words in titles of articles and books, and italicise book and journal titles. Remember that the ampersand is used in the title of Science & Education.

The journal's format and style guide can be seen at the web address below, or at .

If you have not already done so, an 'About the Author' statement needs to be sent directly to myself. E-mailing is the most convenient way to do this. The usual structure is: current position, education, some major publications and/or research interests. This should be done as soon as possible.

The revised SCED file and Response to Reviewers file can be sent to:

Use the log-in name and password that you have already been given.

Regards,

A/Prof. Michael R. Matthews Professor Sibel Erduran

Reviewer #1:

This is a well written paper raising important issues regarding the constitutive pluralism and the teaching of chemistry. The authors attempt to characterize the teaching and curriculum of chemistry

orientated by the philosophy of chemistry. The following recommendations may help to improve the writing:

* On p. 3, third paragraph, the authors give a brief introduction for the structuring of the remainder of the manuscript. Here it would be clearer if the authors explain what they mean by "structuring field", "dimensions of chemistry thought" and "didactic of chemistry". Figure 1 on the same page needs to be translated to English.

The constitutive pluralism of Chemistry is essentially a praxis pluralism, where praxis is the dialogue in a bakthinian (Bakhtin, 1993) sense between theory and practice.

These dialogues may be organized in “structuring fields” (Aduriz-Bravo, 2001) which are the coherent sets of fundamental ideas on which the academic discipline`s identity is built.

Therefore the dimensions of chemistry thought become much more dimensions of Chemical Praxis, which are transcendent structures characterizing the chemical action or “modus operandi” in the various circumstances of chemical applications. Associated to these structures are also styles of chemical thought (apud Bensaude-Vincent), paradigms (Kuhn) , research programs (Lakatos), themata (Toulmin??) in as much as they help to define the particular chemical praxis in each instance

We agree that for the purpose of this paper the use of Chemical Didactics should be abolished and substituted by the use of the less ambiguous (to the international readership of the magazine) concept of Chemical Education that needs not be defined. This is particularly reflected on the criticism of referee #2 that concludes from the use of this expression that the interest of the issue could be narrowed as many of the readers (the ones belonging to the Anglo- Saxon culture) could be turned off because of the use of this concept. It is true that there are two distinct traditions in Science Education (The curricular and the Didactic) with different learning basis and teaching consequences (Hopmann & Riquarts, 1995) but the issue being dealt applies to both traditions an although detected from the research of a Portuguese University is of much broader interest and applicability in both traditions (contradicting the comments ahead of referee#2)

* On p. 7 the authors talk about different types of pluralism discoursed by "several" philosophers. Two philosophers (Schummer and Bachelard) are cited. If there are other scholars, these scholars and their work need to discussed, as well. The three different types of pluralism deserve more attention.

We agree with this comment of ref#1:

On top of that we should add one further type of pluralism: the axiologic (REF[a]) and another author (Lombardi, 2002)

summary Characterization of the pluralisms:

Ontologic Pluralism---originates in the dichotomy of process philosophy (Whitehead,) and substance philosophy (Duhem,). The consequence of this ambiguity is that the fundamental concepts of Chemistry may either be the substances or the reactions. The ontologic pluralism ism of chemistry is exemplified by the basic units of chemistry being either the substances (as Parmenides sustained) or the reactions among them (as Heraclit believed). The definition of the basic units are not made arbitrarily but so that they define groups with characteristic spatial and temporal symmetries. This leads to units so diverse as atoms, molecules and dissipative structures such as flames and auto-catalytic periodic reactions.

Epistemologic pluralism---Arrises from the ambiguity between adopting -projective costructivism- (Le Moigne,1995) as the contemporary Sciences generally do and maintaining the conventional logical positivism (Carnap, 1946) as many sectors of Science still adopt. The main consequence is the way you consider Chemistry: from a project of knowledge (constructivism) to an object of knowledge (positivism).

This epistemologic pluralismis, are due to a gnosological focus either on being or on becoming and also to a fluctuation between deterministic and teleological explanations. In chemistry this is reflected by the use of both observable and non-observable concepts (Mulder, 2011) the latter justified by a constructivist projective epistemology (Eriksson, 1997), regarding science more as a project of knowledge than as an object of knowledge.

The methodological pluralism is due to the fact that either there is no such a thing as the scientific method in the making of Science (Feyerabend,, 1975), although it is used as the essential criterium for communicating science or, at least, that, the so called scientific method is onlyapplied to formalized closed Science and never to Science on the making (Elkana,1970). This is a believe that all contemporary sciences share with Chemistry and the methods (both analytical and synthetical) produce Scientific discourse relying either on the constructivist principle of intelligent action or on the positivistic principle of sufficient reason (Costa Pereira, 2007, p 102).

Axiologic pluralism - means that several values are associated with science (Laudan, 1984) and not only the discovery of truth characteristic of Mode 1 of producing science devoted to explanation (Gibbons et al, 1994). This is particulary important in Mode 2 of producing science devoted to problem solving (Costa Pereira, 2007, pag 290) and this is very much the case of the dominant relationship between Academy and Chemical industry. Other modes of producing Science (as mode 3 oriented to the future) exist (Costa Pereira, 2007, pag 290) but are not very popular in the Chemistry tradition

* In the section "Dimensions of Chemistry Thinking" it would be more helpful if the authors elaborate more on the links between these dimensions and the curricular and teaching implications. It is not clear if the authors are the proposers of certain teaching and learning styles or if these have been already discussed by the philosophers associated with the dimensions. Also, a larger gap exists in the writing between contemporary chemistry education research literature and the dimensions. The links provided are only temporary and these need to be strengthened.

Although the authors would like to find a way of teaching/ learning Chemistry according to its Philosophy, such Philosophy or philosophies were not set “a Priori” but their basic points were empirically searched through the analysis of several specialized magazine articles and also extracted from expert interviews (see). Subsequently the proposal has been validated by focal groups of experts in Chemical Education at the University of Porto (Portugal), Federal University of Bahia (Brazil) and University of Buenos Aires (Argentina).

* Section 4 on "Historiography of Chemistry and the dimensions of thought in Chemistry" needs to be expanded to discuss in more detail the influence of physics on the discipline of chemistry as well as the controversies between thought dimensions.

Chemistry has always been the central Science and, up to the 19th century the leading Science, attracting the attention of many leading scientists, as Isaac Newton very successful and well known

in Physics but not so much in Chemistry as he, despite the fact of putting up a research programme for Chemistry In is celebrated Question 17, failed completely on his attempt to explain chemical affinity through general entities as mass acting at a distance, as he had succeeded for gravity. He and other corpuscularians, as Boyle failed to recognize the particular nature of chemical relations, in the case chemical affinity, that Geoffroy discovered and published in his affinity tables (Bernal & Daza, 2010).

The reduction of Chemistry to Physics almost occurred during the first half of the 20th century, when trying to discover the functions of the recently discovered electrons. In fact, clear attempts to reduce Chemistry to Physics were done, both using a classical view of the electrons and a quantic one. The first was attempted by Lewis (covalence theory), Ingold (Organic reaction Mechanisms), Langmuir, Nyholm, Gillespie (stereochemistry through repulsion of electronic pairs). The quantic view was started by Linus Pauling (ref) and developed into the still widely accepted chemical foundation theories: Valence Bond and Molecular Orbital, with results still affecting the discipline, that could only recover its independence after the subject of reduction and in particular Physicalism has been taken as one of the most important topics of the new born Philosophy of Chemistry (ref). Physicalism that had been proudly announced by Dirac (when he said that all chemistry was explained by quantum mechanics) was rejected chiefly because the fundamental Chemistry concepts (the orbitals) could not be deduced from quantum mechanics (Scerri), and also as the identity of chemistry was characterized by different types of relations (Bernal & Daza, 2010), by a different style of laws (Scerri) , by a different style of thinking (Bensaude- Vincent) and, above all, as the entities of chemical ontology (atoms, molecules, flames, auto-catalytic reaction cycles) should be characterized by the symmetry operations of the group they belong (Earley, 2006).

The pedagogic consequences of the triumphant physicalism were enormous and emerged chiefly on the curricular revolution after the first Sputnik, namely the A level Physical Science curriculum, sponsored by the Nuffield Foundation, which assembled excellent materials but proved too difficult both for students and even more so to teachers. This is possibly because of the irreducibility of the disciplines, although the problem of reduction is probably best treated through an intermediate position (Scerri, 2006). The present situation is that in many countries the two disciplines Physics and Chemistry are associated not always through the curriculum but frequently by the teacher that is the same for the two subjects. This implies that these teachers are recruited among graduates in Chemistry and Physics and may be seen as a reflexion of the reductionist view.

Some countries adopted a different strategy for their curriculum/ teaching associating Chemistry with Biology and Physics with Mathematics, invoking similar epistemologies and methodologies (Physics and Mathematics being nomothetic and Chemistry and Biology ideographic) for these pairs of disciplines. This association between Chemistry and Biology at a secondary level (e.g. in Italy) is inspired in the problem of emergence (of Chemistry in Biology) as its solution becomes very important to empower the students with scientific literacy particularly because the concept of auto-organization is central to the current scientific paradigm , and specially because Biology is the science that sets the agenda for the 21st century.

WE agree with your comments THEN we will include the texts above that should be enough for an introductory paper

.

* Section 5 may include reflections on the relationships between dimensions of chemistry thinking as observed in particular chemistry curricula (i.e., in Portugal).

We believe that the Portuguese secondary Chemical curriculum is not well constructed and our teleological aim is to replace it with one inspired in the recent works of PHILOSOPHY OF CHEMISTRY AND THE PRACTICE OF EXPERTS. We also would like for the purpose of this article

and its readership not to particularize too much the examples given as we believe they are applicable everywhere

* Finally, there is room for improving the drawing of the figures (especially 5 and 6), and the paper needs to be edited for its English language.

the improvement of the figures and the text has been attempted as advised

Reviewer #2:

Comments on

Constitutive pluralism of chemistry: thought planning, curriculum, epistemological and didactic orientations

Overall summary

The paper drafts a way of thinking about chemistry didactics being developed at a specific Portuguese university. The ideas build on a strong European didactic tradition, drawing on aspects of five contributory philosophers' output to construct a putative organisational framework of chemical knowledge that could be used to structure teaching.

By reasons explained above the authors although recognizing the existence of two traditions (Curriculum & Didactics) in Science Education do not subscribe any of them and prefer to refer to their field as Chemical Education with hybrid tendencies: bottom –up from the curricular tradition and top -down from the didactic tradition. This hybrid tendency is very widely spread since American Universities started importing, in the beginning of the 20th century programs from german universities. Certainly this is the tendency that the authors follow, not only because one of them has a Ph D in Chemical Education obtained at a British University, but chiefly because the discipline of the 1st semester preceding the one in which the paper is based is built on the critical analysis of the Salters Chemistry Advanced Level syllabus . We agree to remove most of the references to Chemical didactics and substitute by Chemical Education.

Although the ideas represented are interesting and potentially useful, the paper is yet limited by lack of detail in terms of the philosophical contributions identified and surrounding the central notion which builds on these, namely, the "chemical dimensions of thinking". The nature of such thinking is not fully articulated, in part because the strands on which it relies are poorly defined. Thus, overall, the paper reads as "unfinished business" that would merit detailed attention on a more polished product. At present therefore, the title is rather over-ambitious, so the paper does not fulfil the suggested complex "pluralism" to the extent that it should to justify publication.

We agree that the Chemical dimensions of thinking must be better defined and even related to chemical praxiology and this is what we try to do in answer to referee#1. We think to have succeeded in putting the most emphasis not only in the dimensions but in chemical praxis. This is not incoherent with Bakhtin (1981) interpretation of the dialogue between theory and practice and even more with the associated Leontev`s Activity Theory (1978) which considers thought as an epiphenomenon of action

We don´t think that the title is too ambitious although its development and explanation involves a certain degree of complexity. We think that his moderate ambition should be tolerated because of the urgency of the problem and we draw attention to the fact that contemporary Science is much more based on Problem solving than in explanation and does not reject complexity.

Nevertheless we are conscious of possible deficiencies of this approach for several reasons: time for the maturity of many concepts is short, there is a clear shortage of analitical guides through Chemical Education for the relations between phylosophy, chemistry and the

curriculum what makes urgent its research because by and large the main tendencies in Chemical Education (probably more so than other Sciences Education is that to teach Chemistry does not involve an explicit philosophical position (Chamizo, 2009) and this results in a Chemical Education research almost completely restricted to methodological (many time minor) problems! We believe that our work is situated in that void of finding foundations for Chemical Education in the praxis of Chemistry itsel and its epiphenomemal thought and in approching the Chemistry taught to the Chemistry done. Therefore as we believe that this foundation must be rooted in the Chemical Praxis, constitutive of this pluralism we think that the title accomplishes its function.

In fact, the title of the article presents the nuclear idea that we chose as the foundation of Chemical Education and we believe may be central in the research of both traditions: curricular an didactical . As it is not well researched an introductory approach was planned but especially with some excellent comments of the reviewers grew a little more than initially expected. We hope to improve it further with the help of future research in the international community in order to found the Chemical teaching/ learning in its own praxis, in the dimensions of its thought, always having in mind its constitutive plurality!

There are also other issues: for example, while Europeans (excepting many British educators) are fairly used to the notion of "didactics", a wider international audience may require a more secure foundation for such a study. Hence, the international value for the work, including statements of its purpose and any problems arising from current theoretical chemical frameworks need clear identification. Terminology and names of key individuals are inconsistent throughout the paper, generating a succession of minor irritations for the reader.

We decided to remove the “European” centralized , top-down term and use instead Chemical Education that invokes a corpus of knowledge common to both traditions (curriculum and didactics) and will suit the readership of S&E. We tried to correct inconsistencies and add citations to support the main ideas

More detailed comments are provided below. Detailed comments 1. Problem and purpose The authors state that the work arose from challenges experienced in a named university department. While this is a good local reason, it would be helpful to set the study in the wider context of chemistry philosophy, such as by indicating issues/ challenges that a current philosophy is unable to solve and relating these to an international perspective.

This would enable the reader to locate the study accurately, giving clarity to the desired purpose of offering a novel structure for chemistry philosophy. The opening pages (there are no page numbers) are not useful in this regard at present. Something that may be a more useful starting point arises mid-way on p 6 ("In the field?"), as this hints at chemistry philosophy being under-researched and offering a characterisation of the subject. A question is also raised relating to the subject's axiology and epistemology, which bears investigation.

The fact that the work arose in a named university department while planning a discipline propedeutic to the Chemistry teacher profession does not exclude that all the major problems of the world (the University mission so obliges) and their evolution were contemplated. One of them is the universal unsatisfaction with the science curriculum and the Chemistry one in particular. For the solution of this problem in the first semester the authors contemplated a change in the contents and methodology of the curriculum, adopting a critical discussion of Salters Chemistry Advanced Level materials. In the second semester we tried to provide the rationale for the personal theory of education framework for the future teachers, after analyzing a set of the most influential articles I

Hyle and Foundations of Chemistry and interviewing a few experts to find the philosophical basis of chemistry in which are based thougt, action and teaching of that science. This is a completely open , non parochial process that coul be reproduced by each and everyone of the readers of S&E as the editors certainly wish.

A revision of the text of the opening pages (the forgotten numbers were added) attempts to go in the suggested direction. Although we disagree that the product of this research would be “a novel structure for chemistry philosophy, but we see it the other way round, although we aknowledge that philosophy is the root and top of all sciences , in this case the root function is by far the most important, as it could help to organize the discipline itself on recognizing the philosophical disequilibrium of the conventional branches of chemistry

2. Dimensions of chemistry thinking This heading appears on p 10. There is some description here that hints at reasons for choosing the dimensions. However, these need to be more clearly explained, with reasons perhaps for not choosing other potential dimensions. I would also like to see how the dimensions sit with more conventional general philosophies of science such as research programmes, normal/ paradigm changes in science and possibly also conceptions of scientific method.

Our expectation is that these dimensions will have implicit didactic and curricular orientations. Therefore, on analyzing these dimensions we are guided by a pedagogical bias, in particular by a critical and emancipatory pedagogy (Habermas, ?); by substance pedagogy defended by Lee Shulman ( ) conferring centrality to the content syntactic structures and giving Philosophy the function of explaining and orienting praxis; and by the teacher as explainer of substance and by the re- contextualizing concept of Bernstein ( ). .

We think that the concepts of thought styles, themata, paradigm, belong to a very high inclusivity and generality level and that they are not operational from a didactic or curricular point of view , their effect not being comparable with the dimensions of thought and praxis. We believe that the later when described, bear implicitly didactic and curricular orientations and so are more useful as foundations of Chemical Education. This does not invalidate the analysis through other concepts but we believe that our approach has the necessary elements about the Chemistry “modus faciendi” and indirectly of the communicating and teaching.

I find Fig 4 problematic (and also Fig 6, although for slightly different reasons). The text states that the dimensions are "interdependent". If this is so, then the nature of the interdependence requires careful description in relation to the complex web of relationships these produce, e.g. Duhem - Peirce, Duhem - Prigogine, etc. Also, if there is an assumption that the five dimensions in some way combine together to generate the new concept of "chemical dimensions of thinking - what might this look like, and why? What follows this section is descriptions of each of the five dimensions as individual components, not the interdependence. And it is on the interdependence that the success of the model relies.

The difficulty of answering the question of justifying these precise 5 dimensions of thought led the authors to base their arguments not SO MUCH on the thoughts of some Chemist/Philosophers but on the activities of which, according to Leontev ( ) these thoughts are phenomenological complements. This brings the philosopher/scientist approach closer to certain types of thought dominant in the several activities/ branches of chemistry that require more this thought. What one sees is that in the several branches of Chemistry there is predominance of certain types of thought but they are far from being exclusive. As to the relations among the types of thought they are dialogical in a Bakhtinian sense and they must be researched through the study of the dialogues

sustained in the activities where the types of thought are dominant. This way of researching the interdependence is one of the strengths of the model , no doubt a guarantee of its success as referee #2 puts it.

The question of why not others (dimensions of thought) is an interesting one but the fact is that the current chemical activities are well described through the chosen 5 types of thought. With due respect, the examples given by referee #2 are more formal categories of contemporary philosophical theories than psychologically validated categories of thought. In our view the most important issue in this matter is to find if there is a sort of hierarchy in these types of thought, starting from a dicothomy of substance and process thought in which to base a static and dynamic Chemistry, each of them using other lower level types of thought. But this would require a major reorganization of the entire discipline of Chemistry-Thiis is to much for the purpose and dimension of this article and although we admit that the tacit dimension is the most difficult to capture through dialogue research (it can only be inferred) it is possibly the most important and most related to the other dimensions.

We arrived at these five dimensions through a thematic analysis of Philosophy of Chemistry mostly through Hyle and Foundations of Chemistry publications sub-specializations within the field. These sub-specializations or dimensions were subsequently corroborated through interviews of 5 experts, on both fields (Chemistry and Philosophy). They answered the questions: what are the difficulties in thinking Chemistry and what were the curricular implications of them. Later this proposal was validated through focal groups of Chemical Educators at the Universities of Buenos Aires (Argentina), Bahia (Brazil) and Porto (Portugal).

In order to fulfill the introductory purpose and keep the restricted dimension of the article i t is impossible to establish and describe all the possible relations among the dimensions of chemical thought. We hope they will be the subject of future research either from us and from other researchers of the international community

The only relation we eplicitly anticipate is that the tacit dimension is the most inclusive in Chemica Praxis confering a certain centrality of praxiology and axiology in Chemical Education.

The transition from Fig 4 - Fig 6 is also difficult to follow. In Fig 6 similar terminology is used to that in Fig 4, but the links between them end at that point. What exactly is/ are the connection(s)? Figure 6 implies a hierarchical arrangement between three of the five dimensions, but this is not fully justified. Also, links are shown between the dimensions which are not explained - which relates to my point about the inter-related nature of these, made above.

Hence, the model is at best, tentative, and would benefit from application of examples to help justify its structure.

Figure 4 shows the dimensions of Chemical Thought and some didactic inter-relations. Figure 6 aims at demonstrating how the dimensions of chemical thought are related didacticaly in the discipline relating them to the sub-disciplines, to the ChemicaL Education traditions and the teaching practices in relation to which the authors believe that the dimensions of thought are transversal..

3. Pedagogical - theoretical links On p 7, three (the authors claim four, but only list three) "difficulties in thinking in chemistry pedagogically" are listed. Again we read descriptions rather than detailed examples. Thus, the reader is left making conclusions. For example, in what way does chemistry "lack disciplinary identity"? Please justify these points. In general, the value for the proposed model would be enhanced if pedagogically driven needs could be clearly identified that the model helps to assuage. Thus, pedagogical -theoretical links need to be strengthened. Indeed, a major concern for the didactic tradition is ensuring that it is grounded in the reality of teaching and chemistry as a practical science, rather than relying entirely on philosophical justifications. If this can be addressed, the potential audience for the paper is enhanced.

The fourth difficulty in thinking chemistry (that will be explicity added to the text) is the constitutive plurality of chemistry that will be developed in the subsequent section of the text.

Bensaude-Vicent (1992) defends that chemistry is a science searching for ists territory and for its identitity. And builds the entire History of Chemistry on this adventure. Recently a congress on history of Chemistry has been dedicated also to the identitity.

Recently also a History of Chemistry congress has been dedicated to the Chemistry identity theme. All these studies show what we referred above, that initially, under the influence of Physics Chemistry has been considered a Reduced Science. More recently, under the influence of Biology the tendency is to be considered a Service Science

The lack of clear and explicit objectives in curriculum produces the loss of compreensitivity and intelligibility (Schummer, 1997) and also the identification of rational criteria for seleccion and organization of contents (Tanner & Tanner, 2005) leaving to the practitioners of these curricula the definition of these criteria, a situation that facilitates the hdden curriculum and turns according to Bernstein (1990) the learning more difficult as it depends on explicit criteria.

4. Descriptions of the dimensions From p 12 onwards, the authors simply describe, in varying levels of detail, the five contributing components of their framework. My view is that all of these should be defined much more clearly. At the moment there is a sense of a "small fish" being "caught" from each of the significant outputs of the five contributors, who were major figures not only in chemistry but other fields. There is a need to avoid the danger of taking a tiny aspect of the contributors' work out of context and misapplying it to a framework that misconstrues original meaning and intention. I am not suggesting this has occurred, only that to avoid this, the authors need to justify their choices in more depth, drawing the links between the contributors and examples from chemistry as they proceed. This would help to construct the framework convincingly, suggesting an element of analysis and critique. It may also be worth pointing out reasons for de-selecting other potential contributors.

Most of the authors/philosophers quoted were either chemists or interacted with Chemistry. They do not esgotam the problems of the dimension, neither are the only ones to approach the theme. For instance, regarding the diagrammatic dimension, we may quote Cassirer (ref)

and regarding the processual dimension we should quote Whitehead (ref). Nevertheless the selected authors were chosen on the basis of the quotations on works in Philosophy of Chemistry because they already had their Works considered in the corpus of Chemical Education research and also because they have explicited in their philosophical systems the characteristics of Chemistry ´s "modus operandi" and may contribute with important philosophical foundations. For instance, Duhem showed the importance of classifications; Peirce the importance of relational logic, of pragmatism diagramaticity of Chemistry thought; Polanyi showed the tacit dimension; Bachelard presented the important concept of phenomenotechny and Prigogine a processuality of Chemical thought. This organization has been validated by experts working in the interface of Philosophy and Chemistry at the Universities of Buenos Aires, Bahia (Federal) e Porto

We may ask up to what extent Chemistry has not been a central influence of the mentioned authors. Bensaud-Vicent (2009) says that Chemistry hás been central for the génesis of the concept of phenomenotechny in Bachelard and Seibt (2001) has defended that Chemistry was important for Peirce to construct his philosophical system, mainly the relational logic and pragmatism. To go in more detail about each of the presented dimensions and to explore their complicated relations is the aim of future research and publications and not of this one that essentially aims at presenting the important problem to a large audience that is the large redership of S & R. We sincerely hope that many, more detailed research and articles will follow not only from the authors but also from reaers inspired by the challenges presented in this introductory paper.

5. Consistency of terminology and spelling, developing a stronger discursive style The paper would be strengthened by using commonly used terms such as "epistemology" rather than "gnoseology" and "semiotics" rather than "sign"; avoiding "valorisation"; also spelling "Peirce" consistently correctly; and generally tightening up language. Allied to this is the need to avoid pages such as 19 which has three paragraphs all starting "Another point/ question/ issue"; and 6, which features numerous extremely short paragraphs. In places, the paper reads as a rather complex list rather than true discussion of issues.

We agree and corrected according to some of the suggestions presented. But we cannot agree with the referee´s opinion about equivalence of epistemology and gnosology, the later being na important parto f the former but nota t all equivalent. A certain philosophical precision is important throughout this paper as the authors aim to invite to conciliate Science Didactics and General Philosophy (Ariza & Colo, 2011). In this sense we try to use the rigorous language of philosophy and not the permissive language of didactics.

We accepted and corrected the remarks on page 19 .

Reviewer #3:

Dear Authors; Given that I'm not an 'expert', nor rutinely involved 'professionally, in the 'branch' of -- the Philosophy and History of Science, nor of CHEMISTRY, all my coments/suggestions/reflections/recommendations (below), reflect my personal views,

conceptualisation, science/chemistry edudational perspective and 'world outlook' concerning the teaching and (more so) the learning of Science/chemistry in the STES context... and almost 4 decades of active research, teaching,assessment, curriculum developent and active involvement in science/chemistry education.

1. the first parts of your paper are too long, containing several introductory-type 'descriptions' of the 'existig situation' (from the Philosophy & History of Science/Cemistry perspective), as well as the related Literature review, on the descriptive level (and from the same perspective)that do not say much to those science/ CHEMISTRY education prospective readers. Also it is not clear to, nor convincing, the reader that CHEMISTRY -- didactically/pedagogically/pilosophically/'curicularily' etc., has to be dealt with differently than the other science disciplines. My suggestion: Condese/shorten considerably,sections 1&2.

The introduction attempts to show the historical context of the role of Philosophy of Chemistry in Chemical Education: research, curriculum and teaching, We agree that it might be reduced and so we eliminated unnecessary parts in the final text. On the other hand we were very concerned with your comment with your question about why CHEMISTRY -- didactically/pedagogically/pilosophically/'curicularily' etc., has to be dealt with differently than the other science disciplines? And provided several texts not only in the introduction to support our view of the special treatment of chemistry du to its special Philosophy and inspired on it.

2.Given that almost with no exception, science c urricula -- World-wide,are NOT research-based, any suggestion you make concerning the guidelines for the development and implementation of a cognitively meanigful course (the essence of which is "The philosophy and History of Chemistry"),has to be, at least as far as its goals' attainment is concerned, based on supporting results of a corresponding research.

We accept the critic and suggestion and will add,, accordingly, the following text

Philosophy of chemistry is an emergent disciplinary field in the philosophy of science. In fact Chemistry has been phylosophically wiped out of the scientific panorama by Kant because of not being based on “a priori” knowledge. This fact although attenuated by one of Kant`s postumous writings (ref) contributed to the image of “pot boilers and stamp collectors” attributed to the chemists until they started to set the scientific agenda specially in the 19th century , during the second industrial revolution. In the present, Chemistry has recovered some prestige in its a priori foundations: in Mathematics through group theory1 which characterizes its units; in Physics through quantum mechanics (because of the small size) and statistic mechanics (because of the huge number) to which on top of a relation of supevenience (ref) a relationship of quasi reduction, as explained above (Scerri) exists(ref); and to Biology whose main concepts emerge from Chemistry. Possibly because of all these factors Philosophy of Chemistry started in the 1990 decade having currently two periodic: Hyle (from 1995) and Foundations of Chemistry (from 1999) and an International Society, ISPC (International Society for the Philosophy of Chemistry) that promotes annual encounters. In these years of existence Philosophy of Chemistry literature already consists of about 70

monographies and around 800 articles, extrapolating from 2006 Schummer data (Schummer, 2006) and a vast international community capable of inspiring the world´s best known journals as S&R to dedicate special issues to the theme as is currently the case.

3.In my view,section 3.1 is a kind of extention of what has been described/presented/discussed before.Focusing here on your proposed model/structue/teaching, learning and assessment strategies of your intended curriculum development and related chemistry course implementation, would be more useful to the potential readers.

In the begining of each section the authors introduced a synthetic table of the didactic relations that is expected to act as an Advanced Organizer (Ausubel, A relation and a proposal that we do, based on the analysis of the Chemical Education Research publications we consult is as follows:: the tacit dimension enables the teaching/learng through a practice community and this community must be oriented by praxiology and axiology of the scientific practice ; the phenomenotechnic dimension as it “lives” in the instrument must be oriented by a pragmatic and instrumental philosophy; the classi ficatory dimension must be oriented by conceptual learning and through the integration of elements of natural philosophy; the diagrammatic dimension should be oriented by modeling and by a necessary integration of semiotic elements ;for the processual dimension it is not yet possible to establish a definite teaching/learning strategy but we suggest a rizomatic teaching (ref), the use of nets, maps this being eased by the introduction of elements of process philosophy.

4.Since sections 3.3-5 contain historical-theoretical review/discussion of the chemistry thought and its core dimensions, which in turn boils dowm to the main issue related to Chemistry curriculum development: What should be done? (the objectives); What can be done, given the constraints; How to do what has been agreed upon (teaching strategies and assessment methodologies), it is vital[in my (the reviewer view), that they will end section 5 with a valid/researh-based "guiding model" for the development of a curriculum type, in chemistry, that they are advocating.

All of these elements were thought and some of them executed but as we stated in the begining of the article its ai mis simply to show the bundle of ideas that should orient both the making and the teaching of the discipline. Later we can think on other curricular dimensions namely the objectives, contents, didactic resources an assessment. We think in leaving to other space (other article following shortly) the analysis and crossing of these inter-curricular relations.

Finally-

5.The conclusions may be 'correct', but they are not evolving, necesarily, from the paper per se.

We agree and in order to give more coherence with the body of the text we added the following to the conclusion:

Chemistry is a science strongly inscribed in classificatory criteria and directed by practical reason, using diagramatic, symbolic, relational, procedural and heuristic thinking, influenced

by esthetic values specially of creation and innovation, and dependent on many instruments and technics. Also influenced by Physics the epistemological context of Chemistry and its pedagogical apparatus have chosen one of the sides of its antinomies (not always the same as Physics has done) : substance / process; tacit/explicit; classification/axiomatization , propositional/diagrammatic (analogic); nomothetic / ideographic; essential / relational (or existential?).
The curriculum oriented through Philosophy of Chemistry that we ultimately are looking for, should pay attention to both sides of the antinomies, analize their inherent tensions and promote a dialogue among them.
This subtle inclusion of the antinomies in the curriculum and pedagogical practices will help the natural consideration of the specific dimensions of Philosophy of Chemistry introduced in this paper. This will lead to a radical change of the teaching/ learning of Science begining by pre- sevice teacher education1 where the following objectives should be accomplished related to the consideration of the new characteristics of Chemical Science:

(1)- An ontology not considering only the fundamental particles as the still very strong physicalist tradition did but that recognizes the existence of entities as structures, at all levels, possessing causal power. It is because of that. on top of the traditional compounds other chemical entities are considered such as dissipative structures in open systems far from equilibrium (as the flames) and as temporal symmetry is also included certain cycles of autocatalytic reactions on the basis of auto-organization and generally all the coherent structures whose symmetry properties function as a group, that is exhibit closure.(Del Re, 1998; Earley, 2000, 2003, 2006, 2011).

(2)-A constructivist epistemology (Costa Pereira, 2007, p 99-111) in oposition to the positivist, inspired in the obsolete logic positivism of the Viena Circle that considers Science as a Project (projective constructivism) and is based on a phenomenologic and teleologicgnoseology and in a methodology of systemic modelling oriented by the principle of intelligent action

(3)- A discourse with different orienting principles (pertinence, globalism, teleologism and agregativity) of the cartesian one used by western sciences for centuries (Costa Pereira, 2007, p 88-92).

(4)- A cosmology (Earley, 2004) completely differenciated from the one of ancient Greece (organísmic) but also from the of late Renaissance (mechanistic and atomistic), this one still influencing very strongly the contemporary understanding of Science an especially its teaching. influenciando muito a percepção da ciência actual e o seu ensino. This new cosmology, perhaps better called worldview (weltanshauung in German) first of all does neither hesitate to consider nature with all its complexity nor refuses the use of History, granting for Chemistry the quality of ideographic science instead of nomothetic where it usually was classified.

.(5)-A clear function for metaphisics as the basis of Science through the three fundamental pressupositions that validate Science (Artigas, 2000, p),:

- The ontologic pressuposition, according to which there is a rational order in the Universe

- The epistemologic pressuposition which consists in admitting that Man is capable of understanding the rational order of the universe (or a part of it) through his own reason
- The ethic presupposition is simply the acknowledgement that this activity (the scientific activity).

This set of characteristics of Chemistry as a Science occurs in a particularly interesting moment of History that, for the first time we have a world vision that is complete, rigorous and tightly connected to the ideas of auto-organization, rationality and information (Artigas, 2000) but on the other hand we have to concede that Science hás limitations that force it to transcend itself and demanding help from philosophy, by adopting some philosophical pressupositions that convey meaning to the scientific epopey and are retro-justified by the scientific activity!

Anexos do capítulo 4

4.1 Exemplos de possíveis articulações a partir dos estilos da praxis química

Tabela 6: Exemplos de possíveis articulações dos domínios da praxis química

Dimensão	Tácita	Diagramática	Fenomenotécnica	Classificatória	Processual
Filósofo/químico	Polanyi	Peirce	Bachelard	Pierre Duhem	Prigogine
Referências teórica	Polanyi	Peirce, Humberto Eco, Cassirrer	Bachelard, Ian Hacking, Peter Galisson	Pierre Duhem, Aristóteles	Prigogine, Whitehead
Descritor	Códigos: Heurísticas, protocolos	Signos, Representações, Diagramas	Instrumento	Conceito	Conceito - Processo
Inscrição filosófica	Praxeologia	Pensamento diagramático	Filosofia dos instrumentos	Filosofia natural e da classificação	Filosofia de processos
Principal marco histórico	Artes práticas	1860 – Fórmulas Berzelius	Lavoisier – Balança	Paracelso	Século XX
Relação interdisciplinar	Arte	Linguística	Física Técnica	Biologia, História natural	Física Sistemas abertos
Racionalidade	Prática	Analógica Abdutiva	Racionalismo aplicado Empirismo ativo	Sistematismo	Sistemismo
Método/previsão	Heurística	Transdição	Indução	Sistemismo Retrodição	
Obstáculos filosóficos	Prática irrefletida	Modelo / realidade	Tecnicismo e instrumentalismo	Conceitos primitivos	

4.2 Ficha de trabalho

4.2.1 Auto-avaliação referentes aos conceitos centrais da disciplina didática da química II

	Inìcio				Final			
Sei definir e explicar para os formadores o que é/são	1 Nada	2 Pouco	3 Bastante	4 Muito	1 Nada	2 Pouc	3 Bastante	4 Muito
Filosofia da química	6	2	2			2	3	3
Ontologia	2	6				3	5	
Epistemologia	2	6				2	5	1
Conceitos subsunçores		4	2			3	2	1

e estruturantes								
Conhecimento substantivo da disciplina	6		2			1	7	1
Conhecimento sintáctico da disciplina	2	6				2	5	1
Conhecimento curricular	2	6				1	7	
Conhecimento proposicional		4	2			1	5	
Desenvolvimento profissional dos professores	2	6			1	3	4	
Conhecimento pedagógico do conteúdo	2	6			2	2	4	
Fenomenografia	6	2			2	4	2	
Conhecimento metacognitivo	2	2	2	2		4	2	2
Estratégias de aprendizagem	2		4			2	4	
Conhecimento declarativo	2	6				2	6	
Conhecimento diagramático	6		2			2	6	
Conhecimento tácito	6	2				2	6	
Portfólio		4	2	2		4	4	
Auto-regulação da aprendizagem		4	2			2	4	
Aprendizagem significativa		4	2	2	2	4	2	
Aprendizagem mecânica		2	4	2		4	4	
Transposição didáctica		4	4	2		4	4	
Conhecimento escolar		8				2	6	
Aprendizagem égica		6	2			2	4	

4.2.2 Auto avaliação das competências da disciplina didática da química II

	Início				Final			
Sou capaz	1 Nada	2 Pou	3 Basta	4 Muito	1 Nada	2 Pouco	3 Basta	4 Muito
Explicitar problemas filosóficos da química	6	2				2	6	
Explicitar obstáculos conceptuais da Química		8					6	2
Explicitar obstáculos epistemológicos na Química		8					8	
Relacionar problemas da filosofia da química com o ensino	4	4					8	

Explicitar concepções Filosofia da química com o currículo	4	4				4	4	
Compreender minha própria aprendizagem			6	4		6	4	
Avaliar a evolução da minha aprendizagem			8				8	
Identificar conceitos centrais da Química		6	4			2	4	2
Relacionar Filosofia e Química		8				2	4	2
Analisar concepções epistemológicas no currículo		6	4			4	2	2
Identificar dimensões de pensamento na Química	2	6				2	4	2
Avaliar o meu desempenho como professor	2	6				2	4	2
Identificar meus pressupostos epistemológicos	2	6				2	2	2

4.2.3 Ficha de balanço

4.2.3.1 Balanço da unidade de trabalho

1 – Refira três coisas que aprendeu na sessão.

2 – Como sabe que as aprendeu?

3 – Indique duas "coisas" que gostaria de desenvolver mais profundamente.

4 – Como se sentiu durante os trabalhos de Hoje?

4.2.3.2 Balanço da sessão de formação

Reflicta sobre as aprendizagens que realizou

1 – O que aprendeu que não sabia?

2 – O que já sabia mas passou a considerar de outro modo? Porquê?

3 – Que conceitos é capaz de definir com clareza?

4 – Houve algo que tenha querido saber sobre o assunto tratado e que não tenha sido abordado/bem abordado?

O quê? Porquê?

4.4 Proposta do programa da disciplina projetos integrados

Projeto integrado I

Incapacidade das ciências se auto-justificarem: necessidade da adoção de pressupostos filosóficos: pressuposto ontológico, pressuposto epistemológico e pressuposto ético

Metaciências como um saber docente
Modelo complexo de ciência
A filosofia da ciência e a especificidade química
Filosofia pluralista e a especificidade química

Projeto integrado II

Pensando a química – A química no conjunto dos saberes

Existe alguma especificidade ao pensar a química? Qual? -
Como foi pensada, como é pensada, como poderia ser pensada

Filosofia da química: Historiografia de sua constituição.
Centralidade e Isolamento da química no conjunto dos saberes
- Química e física: O reducionismo fisicalista
- Química e biologia: Uma ciência de serviço
- Pluralismo e interdisciplinaridade da *praxis* química
- Principais características da *praxis* química

Múltiplas identidades da química: Cultura, profissão e contextos químicos
- Axiologia química
  - Indústria/Academia: Uma ciência pós-industrial
  - Ética e química: Uma ciência central e útil
  - Natureza/artificial: Uma ciência do artificial
  - Criar/descobrir: Uma ciência criativa
- Praxiologia química
  - Ciência/Técnica: Uma tecnociência
  - Método/intervenção: Uma ciência Dual,
- Epistemologia química
  - Explicação: Diagramática/classificatória/experimental
- Ontologia química
  - Uma ciência das substâncias e dos processos

Projetos integrado III

Aprendendo[1] e ensinando química

Domínios transversais e articuladores didáticos e curriculares
Existe alguma especificidade ao ensinar a química? Qual?
Como foi ensinada, como é ensinada, como poderia ser ensinada.

Classificação e organização do conhecimento químico
O estatuto epistemológico das classificações: filosofia da classificação
As classificações na evolução cognitiva da química
As classificações como princípio articulador cognitivo e educativo
Pensamento processual e Lógica relacional do conhecimento químico
O estatuto epistemológico das relações: filosofia de processos
As relações na evolução cognitiva da química
As relações como princípio cognitivo e educativo
Semiótica e a diagramaticidade do pensamento químico
O estatuto epistemológico da imagem: pensamento diagramático
As representações na evolução cognitiva da química
O diagrama como princípio cognitivo e educativo
Dimensão tática e pensamento heurístico na química
A heurística e o pensamento tácito na filosofia da ciência
As heurísticas na evolução cognitiva da química
As heurísticas como princípio cognitivo e pedagógico
A filosofia materializada dos instrumentos químicos

Os instrumentos e as técnicas na filosofia da ciência
Os instrumentos e as técnicas na evolução da química
Os instrumentos e as técnicas como princípios cognitivo e pedagógico

4.5 Principais inovações curriculares propostas para o currículo da universidade do porto

Disciplinas	Inovações curriculares	Referências
Projetos integradores sobre filosofia da química: Química, Sociedade e Conhecimento	Disciplina articuladora e integradora com os princípios cognitivos e pedagógicos da química. A disciplina deve ser oferecida no sentido de discutir temas transversais aos domínios específicos em uma abordagem filosófica, histórica e pedagógica da química. Esta disciplina deve oferecer suporte ao ensino/aprendizagem das demais disciplinas.	Referências da filosofia da química, vide abaixo
Fundamentos da química	Introdução dos temas: A lógica do pensamento químico (Schummer, 1998). Evolução histórica e filosófica dos conceitos estruturantes da química: átomo, afinidade, estrutura, equilíbrio, complexidade, Principais tensões da química: continuidade x descontinuidade, e micro x macro, estático x dinâmico, modelo x realidade, Possivelmente adotar um outro manual em face das críticas apresentadas no anexo 1	Schummer (1998) . The Chemical Core of Chemistry I: A Conceptual Approach", Hyle, 4(1998), 129-162. Keith S. Taber (2003). The Atom in the Chemistry Curriculum: Fundamental Concept, Teaching Model or Epistemological Obstacle? 2003, Volume 5, Number 1, Pages 43-84
Laboratório de química I	Introdução do tema: O laboratório e técnicas na evolução cognitiva da química	Baird (1999) Encapsulating Knowledge: The Direct Reading Spectrometer. Foundations of chemistry, 2,1. Rothabart (1999). On the Relationship Between Instrument and Specimen in Chemical Research. Foundations of chemistry, 1,3
Química Inorgânica	Introdução do tema: As classificações na evolução cognitiva da química	Lefèvre (2012) Viewing chemistry through its ways of classifying. Foundations of Chemistry, Santiago Alvarez, Joaquim Sales and Miquel Seco 2008, On books and chemical elements Volume 10, Number 2, Pages 79-100
Química Analítica	Introdução do tema: A revolução instrumental da química	Schummer (2002).The Impact of Instrumentation on Chemical Species Identity", in: P. Morris (ed.): From Classical to Modern Chemistry: The Instrumental

		Revolution, Cambridge: Royal Society of Chemistry, 2002, pp. 188-211.
Química Física	Introdução dos temas: Sistemas dissipativos, termodinâmica longe do equilíbrio e processualidade do pensamento químico	Earley,J(2006), Some Philosophical Influence of Ilya Prigogine Statistical Mechanics , Foundations of Chemistry, 8(3),271-283, Earley,J.(2010),Three Concepts of Chemical Closure and their Epistemological Significance, École Polytechnique, Paris,
Orgânica	Introdução do tema: As representações na evolução cognitiva da química. As representações na evolução cognitiva da química. Diagramaticidade. Estruturalismo	Akeroyd (2000). The Foundations of Modern Organic Chemistry: The Rise of the Hughes and Ingold Theory from 1930–1942. Foundations of chemistry, 2, 2.
Laboratório de Química Inorgânica	Aplicações do tema: As classificações na evolução cognitiva da química	Vide Química Inorgânica
Laboratório de Química Orgânica	Aplicações do tema: As representações na evolução cognitiva da química. As representações na evolução cognitiva da química. Diagramaticidade. Estruturalismo	Vide Química Orgânica
Laboratório de Química Física	Aplicações dos temas: Sistemas dissipativos, termodinâmica longe do equilíbrio e processualidade do pensamento químico	Vide Química Física
Laboratório de analítica	Aplicações do tema: A revolução instrumental da química	Vide Química Analítica

4.6 Proposta de inovação curricular da disciplina historia e filosofia da química (UESB)

METACIÊNCIAS, CURRÍCULO E SABERES DOCENTES	
Saberes docentes (Shulman 2005, 1986).	Curricular, pedagógico, prática, disciplinar, didático
Autonomia da aprendizagem	Autonomia da aprendizagem, fenomenografia, abordagens sobre a aprendizagem, metacognição, auto-regulação das aprendizagens
Metaciências : Modelo complexo de ciência (Adúriz-Bravo, 2001.	Correntes epistemológicas. Modelo complexo de ciência. (gnoseologica, retórica, praxiológica, axiológica) Empoderamento emancipação e humanização
Dimensões e pluralidade da *praxis* química (Ribeiro & Costa pereira, 2012).	Classificatória, diagramática, fenomenotécnica, procesual e tácita
PENSANDO A QUÍMICA – Existe uma forma específica de pensar a química? A especificidade química na filosofia da ciência	

Centralidade e Insulamento da química no conjunto dos saberes	Química e física: O reducionismo fisicalista Química e biologia: Uma ciência de serviço Pluralismo e interdisciplinaridade da *praxis* química Principais características da *praxis* química e imagem da ciência no século XX
Múltiplas identidades da química: Cultura, profissão e contextos químicos	Axiologia química Indústria/Academia: Uma ciência pós-industrial Ética e química: Uma ciência central e útil Natureza/artificial: Uma ciência do artificial Criar/descobrir: uma ciência criativa Praxiologia química Ciência/Técnica: uma tecnociência Método/intervenção: Uma ciência Dual, Epistemologia química Explicação: Uma ciência diagramática/classificatória/experimental Ontologia química: Uma ciência das substâncias e dos processos
COMUNICANDO A QUÍMICA Existe uma forma específica de ensinar a química? Domínios transversais e articuladores didáticos e curriculares	
Classificação e organização do conhecimento químico	O estatuto epistemológico das classificações: filosofia da classificação As classificações na evolução cognitiva da química As classificações como princípio articulador cognitivo e educativo
Pensamento processual e Lógica relacional do conhecimento químico	O estatuto epistemológico das relações: filosofia de processos As relações na evolução cognitiva da química As relações como princípio cognitivo e educativo
Semiótica e a diagramaticidade do pensamento químico	O estatuto epistemológico da imagem: pensamento diagramático As representações na evolução cognitiva da química O diagrama como princípio cognitivo e educativo
Dimensão tática e pensamento heurístico na química	A heurística e o pensamento tácito na filosofia da ciência As heurísticas na evolução cognitiva da química As heurísticas como princípio cognitivo e pedagógioco
A filosofia materializada dos instrumentos químicos	Os instrumentos e as técnicas na filosofia da ciência Os instrumentos e as técnicas na evolução da química Os instrumentos e as técnicas como princípios cognitivo e pedagógico

Anexos Capítulo 5

5.1 Estrutura do curso de Joseph Earley

Part I.

1. *Prologue*: creation stories; metaphor and science; evolution by natural selection; scientific arithmetic.
2. *Origins, Analysis, Structure*: Hominid evolution; social archaeology; prehistoric metallurgy and astronomy; elements, compounds, mixtures; structures of MX salts; chemical and conceptual analysis.
3. *Search for "Principles"*: ancient and medieval achievements; the 'rock' metaphor; atoms and chemical calculations; Galileo and his trial; Newtonian physics; kinetic-molecular theory; heats of reaction.
4. *Particles and Fields*: proton, electron, neutron; electromagnetic spectrum; relativity; isotopes and nuclear stability; fundamental forces and vectors; limits of the 'rock' metaphor.
5. *Periods and Bonds*: periodic properties; electrons in atoms (I); ionic and covalent bonds; shapes of molecules; electronegativity; hydrogen bonds; solubility; science and method.

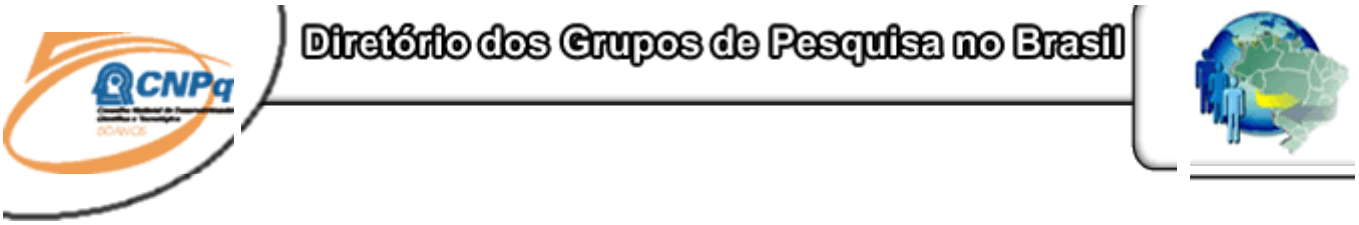
Part II.

6. *The Alternative Metaphor – 'the Flame.'* Oscillating reactions; equilibrium structures and dissipative structures; reaction mechanisms; 'self-assembly' and 'self-organization.'
7. *Origins of Elements*: colors of stars; Big Bang and before, origins of protons, expansion of the Universe; galaxies and stars; the "standard" model, nucleosynthesis, dispersion of atoms.
8. *Thermodynamics and the Earth*: concentration, equilibrium constants; interstellar molecules; solar system and planets; convection; plate tectonics; chemical cycles: Gaia hypothesis; free energy and entropy.
9. *Kinetics, Catalysis, Life*: rates; catalytic cycles; protocells; biological energy storage; photosynthesis; amino acids, enzymes.
10. *Genetics, Symbiosis*: nucleic acids; protein synthesis; genetic code; phage X-174; fermentation, respiration; eucaryotes; sex; *D. Discoidium*.

Part III.

11. *Causality, Closure, Chaos*: quantum indeterminacy; complementarity; electrons in atoms (II); nonlinear dynamics; deterministic chaos.
12. *On Reported Selfishness of Genes*: replicators; genetic variation; kin selection; human altruism (Simon, 1990).
13. *Games, Strategies, Mind*: units of selection; evolutionarily stable strategies; brain structure; memes and cultural evolution.
14. *Technology, Economics, Ecology, and Ideology*: sulfate and chloride processes for titania production – ecological and economic considerations; exploit Madagascar titanium ore deposits? opportunities and responsibilities in evolutionary development.

5.2 Grupo de pesquisa investigações em química, filosofia e currículo



Grupo de Pesquisa

Investigações em Química, Filosofia e Currículo

Identificação | Recursos Humanos | Linhas de Pesquisa | Indicadores do Grupo

Identificação

Dados básicos

Nome do grupo: Investigações em Química, Filosofia e Currículo

Status do grupo: processo de carga

Ano de formação: 2013

Data da última atualização: 05/06/2013 21:39

Líder(es) do grupo: Marcos Antonio Pinto Ribeiro -

Área predominante: Ciências Humanas; Educação

Instituição: Universidade Estadual do Sudoeste da Bahia - UESB

Órgão: Universidade Estadual do Sudoeste da Bahia - **Unidade:** Departamento de Química e Exatas
Campus Jequié

Endereço

Logradouro: Av. José Moreira Sobrinho, S/N

Bairro: Jequiezinho **CEP:** 45206190

Cidade: Jequie **UF:** BA

Telefone: 35288621 **Fax:**

Home page:

Repercussões dos trabalhos do grupo

O núcleo de investigação em Química, Filosofia e Currículo pretende aproximar o debate do campo disciplinar da filosofia da química para pensar problemas relacionados ao ensino, currículo e formação de professores em química. Pretende-se, inicialmente, investigar as mais variadas formas de relações entre filosofia, química e currículo para, a partir dai, localizar novos horizontes teóricos para pensar o sistema de ensino da química. Busca-se propor novos modelos de currículos, perspectivas filosóficas, pedagógicas e curriculares específicas a partir da práxis química. O grupo também pretende produzir material para subsidiar práticas curriculares, principalmente nos cursos de formação inicial de professores de química.

Recursos humanos

Pesquisadores **Total: 15**

Alcione Torres Ribeiro
Braulino Pereira de Santana
Bruno Ferreira dos Santos
Carlos Alberto Andrade Freitas
Luiz Augusto Gesteira de Souza
Luiz Augusto Martins Cardoso
Marcos Antonio Pinto Ribeiro
Ronei Clecio Mocellin

Débora Schmitt Kavalek
Edilson Fortuna de Moradillo
Lídia Nunes Cunha
Lisandro Bacelar da Silva
Siméia dos Santos Cerqueira
Simone Barreto Santos
Telesson Neves Teles

Estudantes	Total: 1

Jirenilda Santos Brito

Técnicos	Total: 0

Linhas de pesquisa	Total: 13

- A presença da química nos clássicos da filosofia
- A presença da razão histórica na química
- Aproximações e distanciamentos entre o pensamento físico e o químico
- Bachelard como um autêntico filósofo da química
- Estruturas, dinâmicas e orientações curriculares a partir da filosofia da química
- Filosofia da educação química
- Inovações curriculares fundamentadas na filosofia da química
- modelo de currículo de química a partir da praxis
- O pensamento diagramático na química
- O pensamento matemático na química
- O pensamento tácito na química
- Paralelos entre a química e a linguística
- Perspetivas não reducionista do ensino de química

Relações com o setor produtivo	Total: 0

Indicadores de recursos humanos do grupo	
Integrantes do grupo	**Total**
Pesquisador(es)	15
Estudante(s)	1
Técnico(s)	0

[1] Esta parte da disciplina destina-se não só nem especialmente aos futuros professores mas a todos os futuros químicos que terão de passar a vida a estudar, atualizando os seus conhecimentos.

[1] Atoms, molecules, crystals and dissipative structures among which we could distinguish stable flames and periodic biochemical autocatalytic cycles which are on the roots of auto-organization a concept central to the current scientific paradigm (Earley, 1999). More recently the closure of the groups that characterize Chemical entities with causal power (then ontological) has been classified in three types named after three distinguished scientists/philosophers: De Broglie, Poincaré and Cauvin

[1] As is the case related in this paper